

that for a certain application we need  $x^2$  value in the range of 0 to 9. We can use a look-up table instead of calculating it.

In addition to being used to access program ROM, DPTR can be used to access memory externally connected to the 8051. Another register used in indexed addressing mode is the program counter. In many of the examples above, the MOV instruction was used for the sake of clarity, even though one can use an  $\text{@R0}$  instruction as long as that instruction supports the addressing mode. For example, the instruction "ADD A, @R0" would add the contents of the memory location pointed to by R0 to the contents of register A.

#### ***Indexed addressing mode and MOVX instruction***

8051 has 64Kbytes of code space under the direct control of the Program Counter register: We just showed how to use the MOVC instruction to access a portion of this 64K-byte-codespace as data memory space. In many applications the size of program code does not leave any room to share the 64Kbyte code space with data. For this reason the 8051 has another 64K bytes of memory space set aside exclusively for data storage. This data memory space is referred to as *external memory* and it is accessed only by the MOVX instruction. In other words, the 8051 has a total of 128K bytes of memory space since 64Kbytes of code added to 64K bytes of data space gives us 128Kbytes. One major difference between the code space and data space is that, unlike code space, the data space cannot be shared between code and data.

### ***LIST OF QUESTIONS***

#### ***PART A***

##### ***1. List the features of 8051 microcontroller.***

The resources offered by 8051 microcontroller are:

1. 8-bit CPU
2. On-chip oscillator
3. 4KB of ROM (Program memory)
4. 128 bytes of RAM (Data memory)
5. 21 Special function registers
6. 32 I/O lines (Ports P0 to P3)
7. 64 KB address space for external data memory
8. 64 KB address space for program memory
9. Two 16-bit timer/counter
10. Five source interrupt structure
11. Full duplex serial port
12. Bit addressability
13. Powerful bit processing capability

##### ***2. List the addressing modes of 8051.***

The various addressing modes of 8051 are as follows:

1. Immediate
2. Register

3. Direct .
4. Register Indirect
5. Indexed

### 3. Write about call statements in 8051?

#### ACALL addr 11 (absolute call)

ACALL unconditionally calls a subroutine located at the indicated address. Since ACALL is a 2-byte instruction, PC is incremented by 2 to point to the next instruction. The destination address is obtained by successively concatenating the five high-order bits of the incremented PC, op-code bits 7-5, and the second byte of the instruction. The subroutine called must, therefore, start within the same 2K block of the program memory as the first byte of the instruction following ACALL. No flags are affected

$$\begin{aligned} (PC) &\leftarrow (PC) + 2 \\ (SP) &\leftarrow (SP) + 1 \\ ((SP) &\leftarrow (PC\ 7-0) \\ (SP) &\leftarrow (SP) + 1 \\ ((SP) &\leftarrow (PC\ 15-8) \\ (PC10-0) &\leftarrow \text{page address} \end{aligned}$$

#### LCALL addr16 (Long call)

The LCALL calls a subroutine located at the indicated address. Since LCALL is a 3-byte instruction, PC is incremented by 3 to point to the next instruction. The destination address is mentioned in absolute term in the instruction as addr16. No flags are affected.

$$\begin{aligned} (PC) &\leftarrow (PC) + 3 \\ (SP) &\leftarrow (SP) + 1 \\ ((SP) &\leftarrow (PC\ 7-0) \\ (SP) &\leftarrow (SP) + 1 \\ ((SP) &\leftarrow (PC\ 15-8) \\ (PC10-0) &\leftarrow \text{page address} \end{aligned}$$

### 4. Give the alternate functions of port pins of port3?

- |      |  |
|------|--|
| P3.0 | Serial Input Line                      |
| P3.1 | Serial Output line                     |
| P3.2 | External Interrupt line (INT0)         |
| P3.3 | External Interrupt line (INT1)         |
| P3.4 | Timer 0 external input (T0)            |
| P3.5 | Timer 1 external input (T1)            |
| P3.6 | External data memory write strobe (WR) |
| P3.7 | External data memory read strobe (RD)  |

### 5. Explain the 16 bit registers DPTR and SP of 8051.

#### Data pointer:

The data pointer (DPTR) is a 16-bit register, consisting of a high byte (DPH) and a low byte (DPL). This register normally contains a 16-bit address.

**Stack Pointer:**

The stack pointer in the 8051 is an 8-bit wide register. This pointer can point to any location in the internal data RAM, i.e. locations from 0-127. When the chip is reset, this register is initialized to 07H. During PUSH and CALL instructions the stack pointer is first incremented and then the data is stored in the stack.

**6.Name the special function registers available in 8051.**

ACC	Accumulator	0E0H
B	B register	0F0H
PSW	Program status word	0D0H
SP	Stack Pointer	81H
DPTR	Data pointer 2 bytes	
DPTR(Low)	Data pointer low	82H
DPTR(High)	Data pointer high	83H
P0	Port 0	80H
P1	Port 1	90H
P2	Port 2	0A0H
P3	Port 3	0B0H
IP	Interrupt Priority Control	0B8H
IE	Interrupt Enable Control	0A8H
TMOD	Timer/counter mode	89H
TCON	Timer/counter control	88H
TH0	(Timer/Counter) 0 High	8CH
TL0	(Timer/Counter) 0 Low	8AH
TH1	(Timer/Counter) 1 High	8DH
TL1	(Timer/Counter) 1 Low	8BH
SCON	Serial control	98
SBUF	Serial Data Buffer	99
PCON	Power Control	87

**7. Differentiate between microprocessor and microcontroller.**

Microprocessor	Microcontroller
Microprocessor contains ALU, control unit, different register and interrupt circuit	Microcontroller contains microprocessor, memory (ROM and RAM) , I/O interfacing circuit and peripheral devices such as A/D converter, serial I/O, timer, etc.
It has many instructions to move data between memory and CPU.	It has one or two instructions to move data between memory and CPU.
It has one or two bit handling instructions.	It has many bit handling instructions

Access time for memory and I/O devices are more	Less access times for built-in memory and I/O devices.
Microprocessor based system requires more hardware.	Microcontroller based system requires less hardware reducing PCB size and increasing the reliability.
Microprocessor based system is more flexible in design point of view.	Less flexible in design point of view.
It has single memory map for data and code	It has separate memory map for data and code.
Less number of pins are multifunctioned.	More number of pins are multifunctioned.

**8. Explain the PSW of 8051 microcontroller**

7	6	5	4	3	2	1	0
CY	AC	FO	RS1	RS0	OV	X	P

- CY - Carry flag
- AC - Auxiliary carry flag
- FO - Overflow flag
- OV - Odd parity flag
- P - User flag 0

RS1	RS0	Register Bank
0	0	Register Bank 0
0	1	Register Bank 1
1	0	Register Bank 2
1	1	Register Bank 3

**9. Give the applications of 8051 microcontroller.**

In real time systems such as speed control of motors, position control, control of physical quantities such as pressure, temperature, etc.,

**PART B**

1. Explain the working of 8051 microcontroller. Give a neat sketch? (16)
2. Discuss in detail the instruction set of 8051 microcontroller? (16)
3. Discuss in detail the addressing modes of 8051 microcontroller? (16)
4. With neat diagram explain the port operation of 8051. (8)