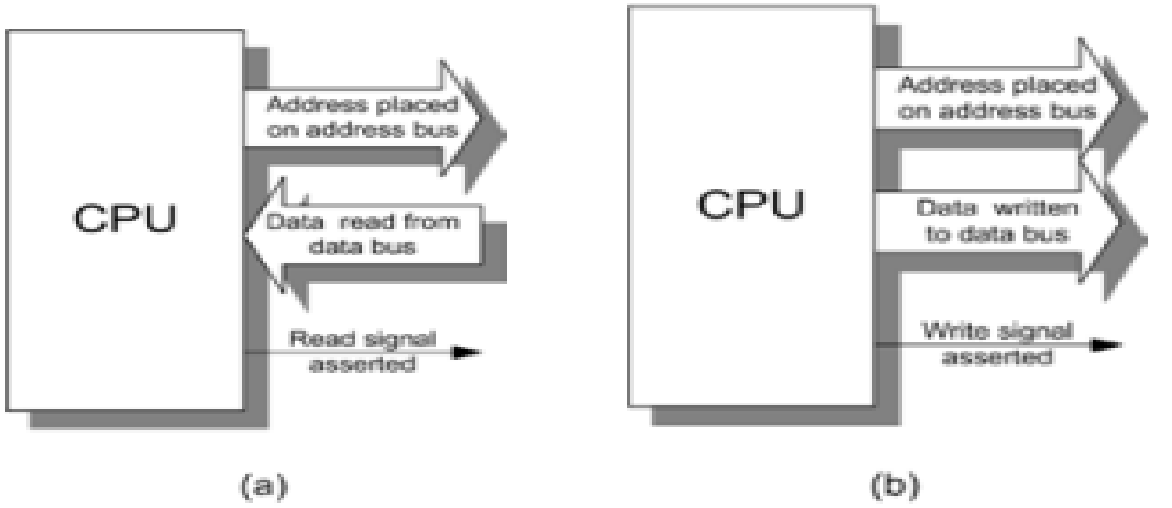
Microprocessor operation

- The majority of operations performed by a microprocessor involve the movement of data.
- The program code (a set of instructions stored in ROM or RAM) must itself be fetched from memory prior to execution.
- The microprocessor thus performs a continuous sequence of instruction fetch and execute cycles.
- The act of fetching an instruction code (or operand or data value) from memory involves a read operation while the act of moving data from the microprocessor to a memory location involves a write operation – see Fig. 11.6.



Read Operation

Write Operation

- Each cycle of CPU operation is known as a machine cycle.
- Program instructions may require several machine cycles (typically between two and five).
- The first machine cycle in any cycle consists of an instruction fetch (the instruction code is read from the memory) and it is known as the M1 cycle.
- Subsequent cycles M2, M3, and so on, depend on the type of instruction that is being executed.
- This fetch-execute sequence is shown in Fig. 11.7.
- Microprocessors determine the source of data (when it is being read) and the destination of data (when it is being written) by placing a unique address on the address bus.
- The address at which the data is to be placed (during a write operation) or from which it is to be fetched (during a read operation) can either constitute part of the memory of the system (in which case it may be within ROM

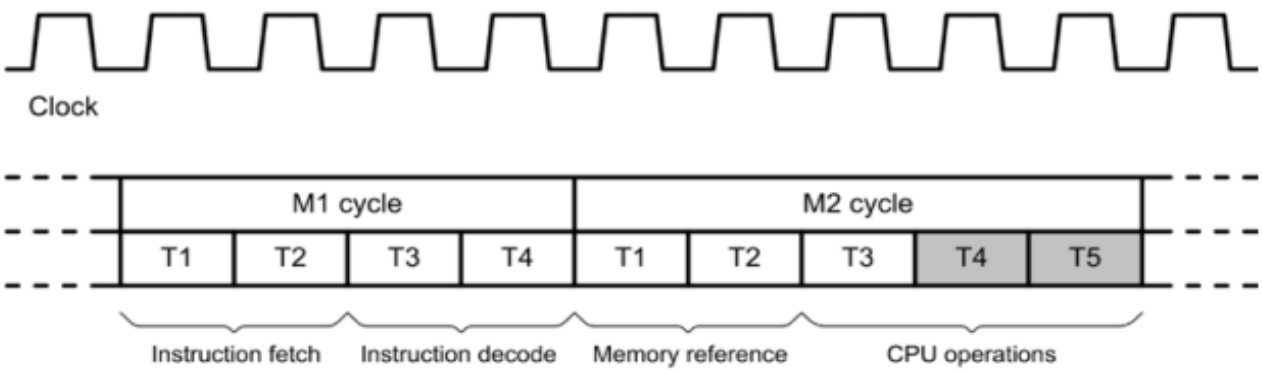


Figure 11.7 A typical timing diagram for a microprocessor's fetch-execute cycle

ALU:

i. The arithmetic logic unit The ALU can perform arithmetic operations (addition and subtraction) and logic (complementation, logical AND, logical OR, etc).
ii. In addition, the ALU status is preserved in the flag register so that, for example, a carry, zero or negative result can be detected.

Control Unit: The control unit is responsible for the movement of data within the CPU and the management of control signals, both internal and external.

Parallel data transfer:

iii. The transfer of data within a microprocessor system involves moving groups of 8, 16 or 32-bits using the bus architecture.
iv. Consequently, it is a transfer data into and out of the system in parallel form.
v. This process is done by using a Programmable Parallel I/O device.
vi. This device provides registers for the temporary storage of data that not only buffer the data but also provide a degree of electrical isolation from the system data bus.
vii. Parallel data transfer is primarily suited to high speed operation over relatively short distances, a typical example being the linking of a microcomputer to an adjacent dot matrix printer

Interrupt:

viii. A program that simply executes a loop indefinitely.
ix. In most microprocessor systems we want to be able to interrupt the normal sequence of program flow in order to alert the microprocessor to the need to do something.
x. We can do this with a signal known **as an interrupt.**
xi. There are two types of interrupt;
xii. maskable and non-maskable. When a non-maskable interrupt input is asserted, the processor must suspend execution of the current instruction and respond immediately to the interrupt. In the case of a maskable interrupt

1) How many unique addresses are available to a microprocessor CPU that has a 20-bit address bus? ANS: 1,048,576
2) 11.6 What is the largest unsigned data value that can appear on a 10-bit data bus? 1,024
3) 11.1 Convert 3A hexadecimal to binary.
4) 11.2 Convert 11000010 binary to hexadecimal.
5) 11.3 Convert 63 decimal to
   (a) binary
   (b) hexadecimal.
6) What is the largest negative data value that can be represented using signed 16-bit binary numbers? ANS: -32,768
7) The following fragment of assembly language code is executed using a Z80 microprocessor:

```
IN A, (FEH)
CPL
OUT (FFH), A
HALT
```

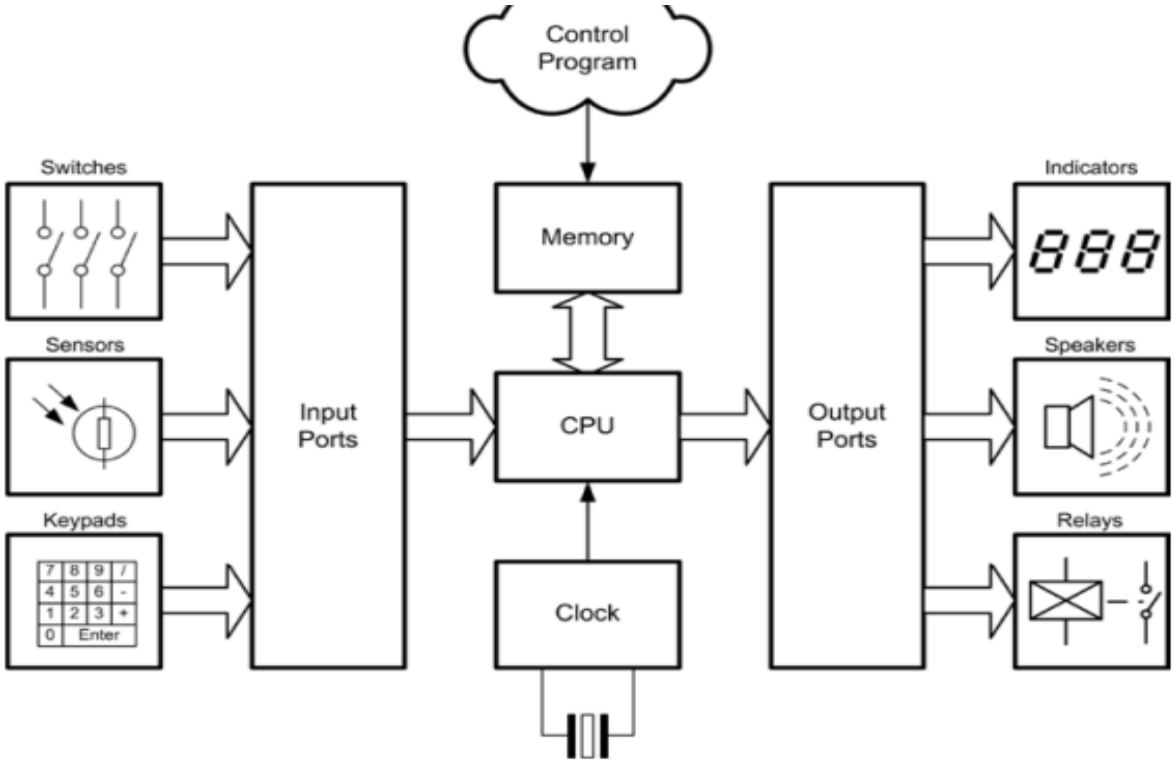
(a) What are the addresses of the input and output ports?

(b) If a data value of 10101111 appears at the input port what value will appear at the output port after the code has been executed?

Ans: (a) Input port, FEH; output port, FFH (b) 01010000

A Microcontroller System

A microcontroller system with typical inputs and outputs



Shows the arrangement of a typical microcontroller system.

- The **sensed quantities** (temperature, position, etc.) are converted to corresponding electrical signals by means of a number of sensors.

- The **outputs from the sensors** (in either digital or analogue form) are passed as input signals to the **microcontrolle**r.
- The microcontroller also accepts inputs from the user.
- These users set options typically include target values for variables.
- The operation of the microcontroller is controlled **by a sequence of software instructions** known as a **control program.**
- The control program operates continuously, examining inputs from sensors, user settings, and time data before making changes to the output signals sent to one or more controlled devices

Microcontrollers must also have a

i. **Central processing unit (CPU**) capable of performing simple arithmetic, logical and timing operations.

ii. **Ports:** A microcontroller must produce a specific state on each of the lines connected to its output ports in response to a particular combination of states present on each of the lines connected to its input ports

The input port signals can be derived from a number of sources including:

— switches (including momentary action pushbuttons)
— sensors (producing logic-level compatible outputs)
— keypads (both encoded and unencoded types).

The **output port** signals can be connected to a number of devices including:

— LED indicators (both individual and multiple bar types)
— LED seven segment displays (via a suitable interface)
— Motors and actuators (both linear and rotary types) via a suitable buffer/driver or a dedicated interface)
— Relays (both conventional electromagnetic types and optically couple solid-state types) transistor drivers and other solid-state switching devices.

iii. **Memory:** Basically 8051 microcontroller consists of on-chip program memory i.e., ROM and on-chip data memory i.e., RAM.

a. ROM is completely a program or code memory that means used by the programmer to store the programs that are to be executed by the microcontroller. The operations that are executed by the device in which the microcontroller is present are stored in the ROM of the memory at the time of fabrication. Hence cannot be changed or modified.
b. RAM is used to store data or operands for only a small time duration. It can be altered anytime according to the need of the user. It is also known as the data memory as it stores the data temporarily.