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Uttar Pradesh
Public Service Commission

Combined State Engineering Services Examination

Assistant Engineer

Mechanical Engineering

Mechatronics and Robotics

Well Illustrated **Theory** *with*
Solved Examples and **Practice Questions**

MADE EASY
Publications

Mechatronics and Robotics

Contents

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Microprocessor, Microcontrollers & PLC

1.1 Introduction

The most important technological invention of modern times is the "microprocessor". A microprocessor is a multiple purpose programmable clock driven, register based electronic device that reads binary instructions from memory, accepts binary data as input and processing this data according to the instructions written in the memory. The microprocessor is capable of performing computing functions and making decisions to change the sequence of program execution. The microprocessor can be embedded in a larger system, and can function as the CPU of a computer called a microcomputer.

Block diagram of microcomputer
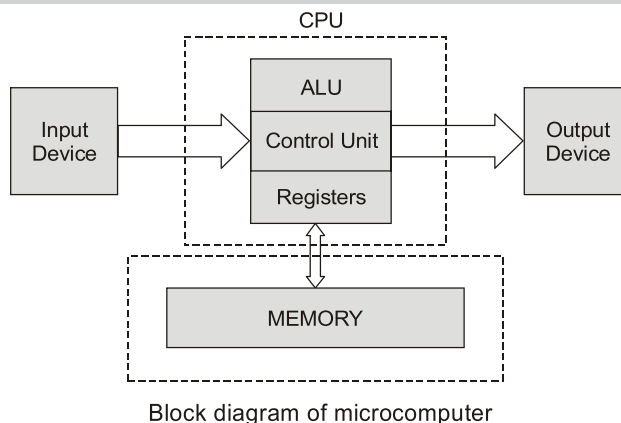
The figures shows the basic block diagram of a microcomputer which processes binary data and traditionally represented by four blocks i.e. CPU, memory, input device and output device.

Here, input device is a device that transfers information from outside world to the computer for example: Key board, mouse, webcam, microphone, scanner, electronic white boards, etc. The output device transfers information from computer to the outside world like monitor, printers (all types), speakers, headphones, projector, plotter, Braille embosser, LCD projection panel, computer output microfilm (COM) etc. Memory is an electronic medium that stores binary information.

Central Processing Unit (CPU) is the heart of computer systems. The microprocessors in any microcomputer act as a CPU. The CPU can be made up with ALU + CU + Registers. Where ALU is the group of circuits that performs arithmetic and logical operations. Control Unit (CU) is a group of circuits that provide timings and signals to all the operations in the computer and controls the data flow.

Microcontroller is a programmable device that includes microprocessor, memory and I/O signal lines on a single chip, fabricated using VLSI technology. Microcontrollers are also known as single chip microcomputers. They are mostly used to perform dedicated functions such as automatic control of equipment, machines and process in industries and consumer appliances.

System Bus

A bus is a group of wires/lines used to transfer data (bits) between components inside a computer or between computers. In most simple form, they are communication path used to carry the signals between microprocessor and peripherals.

The system bus of a microprocessor is of three types:

1.   Address Bus

   • It is a group of lines that are used to send a memory address or a device address from the Microprocessor Unit (MPU) to the memory or the peripheral.

   • The address bus is always uni-directional i.e address always goes out of the microprocessor.

   • If the address line are 'n' for a MPU then its addressing capacity is 2^n.

2.   Data Bus

   • It is a group of lines used to transfer data between the microprocessor and peripherals and/or memory.

   • Data bus is always bi-directional.

3.   Control Bus

   • Control bus provides signals to control the flow of data.

DO YOU KNOW? The internal architecture of the microprocessor unit depends on the data bus width, which is equal to the bit-capacity of the microprocessor.

1.2   History of Microprocessors

A brief review of certain microprocessors were given in the table given below Intel introduced its first 4-bit PMOS microprocessor 4004 in the year 1971. It has 16 pins, 640-bytes of memory addressing capability and 10 address lines. After this enhanced version of 4004, a 4-bit, Intel 4040 was developed. In 1972, Intel introduced its first 8-bit processor Intel 8008, which also uses PMOS technology. The PMOS technology processors were slow and not compatible with TTL logic. These microprocessors could not survive as general purpose microprocessor due to design limitations. In 1974, Intel introduced its more powerful and faster 8 bit NMOS microprocessor Intel 8080. These processors were faster and compatible with TTL logic. Intel 8085 followed 8080 microprocessor. The main limitations of 8 bit microprocessors tempted the designers to go for more powerful processors in terms of advanced architecture, more processing capability, larger memory addressing capability and more powerful instruction set. The Intel 8086 was the result, launched in 1978 . The technology used was HMOS, high speed and high performance MOS technology.

Table: A brief review of various microprocessors

Microprocessor	Word length	Memory capacity
Intel 4004 (PMOS)	4-bit	640 B
Intel 8008	8-bit	16 kB
Intel 8080 (NMOS)	8-bit	64 kB
Intel 8085 (NMOS)	8-bit	64 kB
Intel 8086 (HMOS)	16-bit	1 MB
Intel 8088	8/16-bit	1 MB
Intel 80186	16-bit	1 MB
Intel 80286	16-bit	16 MB real, 4 GB virtual
Intel 80386	32-bit	4 GB real, 4 GB virtual
Intel 80486	32-bit	4 GB real, 64 TB virtual
Pentium-II	64-bit	64 GB real
Z-80	8-bit	64 kB
Z-800	8-bit	500 kB

NOTE: Most of the general purpose microprocessors used in the modern world computers are the family of 8086.

1.3 Computer Language

- **Scale of integration:**
  - **SSI (Small Scale Integration):** The term refers to the technology used to fabricate discrete logic gates on a chip.
  - **MSI (Medium Scale Integration):** The process of designing few tens of gates on a single chip.
  - **LSI (Large Scale Integration):** The process of designing hundreds of gates on a single chip similarly terms VLSI (very large scale integration), ULSI (ultra large scale integration) are used to indicate the scale of integration.
- **Digital computer** is a programmable machine that process binary data. It is traditionally represented by five components: CPU, ALU, CU, memory, input and output.
- **Instruction** is a command in binary that is recognized and executed by the computer in order to accomplish a task. Some instructions are designed with one word, and some require multiple words.
- **Mnemonic** is a combination of letters to suggest the operation of an instruction.
- **Program** is a set of instructions written in a specific sequence for the computer to accomplish a given task.
- **Machine Language** is the binary medium of communication with a computer through a designed set of instructions specific to computer.
- **Assembly Language** is a medium of communication with a computer in which programs are written in mnemonics. An assembly language is specific to a given computer.
- **Low-Level Language** is a medium of communication that is machine-dependent or specific to a given computer. The machine and the assembly languages of a computer are considered low-level languages. Programs written in these languages are not transferrable to different types of machines.
- **High-Level Language** is a medium of communication that is independent of a given computer. Programs are written in English-like words, and they can be executed on a machine using a written translator (a compiler or an interpreter).
- **Compiler** is a program that translates English-like words of a high-level language into the machine language of a computer. A compiler reads a given program, called a source code, in its entirety, and then translates the program into the machine language which is called an object code. (Ex. *C*, *C*++)
- **Interpreter** is a program that translates the English-like statements of a high-level language into the machine language of a computer. An interpreter translates one statement at a time from a source code to an object code. (Ex. BASIC)
- **Assembler** is a computer program that translates an assembly language program from mnemonics to the binary machine code of a computer and these machine codes are called object programme
- **Difference between compiler and interpreter:** Interpreter reads one line of a program at a time, converts it into object code, executes and then reads next line. Whereas, compiler reads whole program at a time and convert it into the object code and then execute.
- **Bit** is a binary digit, 0 or 1.
- **Byte** is a group of eight bits.
- **Nibble** is a group of four bits.
- **Word:** a group of byte the computer recognizes and processes at a time.
- **Subroutine:** a "Subroutine" is a group of instructions written separately from the main program to perform a function that occurs repeatedly in the main program.
- **Cross assembler:** used to translate opcodes of one processor to opcode of another processor.

Example - 1.1 Machine instructions are written using which of the following?

(a) Bits 0 and 1 only
(b) Digits 0 and 9 only
(c) Digits 0 and 9 and the capital alphabets A to Z only
(d) Digits 0 to 9, the capital alphabets A to Z and certain special characters

Solution: (a)
Machine instructions are written using bits 0 and 1 only.

Example - 1.2 Output of the assembler in machine code is referred to as

(a) Object program
(b) Source program
(c) Macroinstruction
(d) Symbolic addressing

Solution: (a)
Output of the assembler in machine code is referred as object program.

Example - 1.3 Which one of the following statements is correct?

A micro-controller differs from a microprocessor in that it has

(a) Both on-chip memory and on-chip ports
(b) Only on-chip memory but not on-chip ports
(c) Only on-chip ports but not on-chip memory
(d) Neither on-chip memory nor on-chip ports

Solution: (a)
A micro-controller differs from a microprocessor in that it has both on-chip memory and on-chip ports.

Example - 1.4 Assertion (A): Many programmers prefer assembly level programming over machine language programming.

Reason (R): It is possible to efficiently utilize the hardware of the computer in machine language programming.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not a correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Solution: (b)
Many programmers prefer assembly level programming over machine language programming because assembly language is simple and easily understandable. So assertion is true. Also it is possible to efficiently utilize the hardware of the computer in machine language programming because the machine language is directly understood by microprocessor.

Application of Microprocessors

A few more applications of microprocessors are:
- A microprocessor based stepping motor controller used for controlling several stepping motors in a pulsed Laser system. The motors are used to precisely align a set of mirrors used in this system.

- There are several other motor control applications reported in the literature, Lin (1977) describes one approach to motor speed control using an SCR chopper.

- A microprocessor controlled Railways Signaling Inter lock was developed to exhibit the applications of microprocessors in signaling. The system monitors train positions in different blocks on a section and sends speed codes to each block. The speed codes are displayed and used by train drivers to control the speed.

- A patient surveillance system was designed using distributed processing.

- Microprocessors have been used in a variety of automation applications. Control of tester for surveillance checking the electronic functioning capability of a target detecting device (Frantz, 1977) is one of these. A microprocessor based blood gas analyzer has been developed by Margalith et al. (1977).

1.4 Microprocessor Architecture

The process of data manipulation and communication is determined by the logic design of microprocessor, called the "Architecture". There are two types of architecture depending upon storage of program and data in memory:

- **Von Neumann architecture of computers**
- **Harvard architecture of computers**

Von Neumann Architecture

The idea of basic organization of a digital computer containing a CPU, a main memory, input and output device and secondary storage devices was given by John Von Neumann in 1945. He introduced the "stored – program concept"-where the programs and data are stored in the same high speed memory unit. In Von Neumann architecture there is a program counter and instructions are executed in sequential manner. The MPU fetches one instruction of the program and executes it, then it goes to the next instruction. The speed of computer is limited by the speed at which the MPU can fetch the instructions and data from the memory and process them. Digital computers based on this principle are called control-flow or control driven computers.

Examples: Intel 8085 and Intel 8086

Harvard Architecture

The enhanced version of Von Neumann architecture is the Harvard architecture. It contains separate instruction memory and data memory. The instruction memory and data memory in Harvard architecture have separate data path , that eliminated the speed limitation of single bus architecture in a Von Neumann processor.

Examples: TMS 32010, Intel 8051, Intel's Pentium. etc.

1.5 Digital Number Systems

Many number systems are used in digital technology. A number system is simply a way to count. The most commonly used number systems are:

- Decimal number system
- Octal number system
- Binary number system
- Hexadecimal number system

A number system with base or radix 'r' will have r number of different digits from 0 to ($r-1$) thus, number system is represented by $(N)_b$

where, N = Number ; b = Base or radix

In general a number with an integer part of 'n' bits and a fraction part of 'm' bits can be written as

$$(N)_b = \underbrace{b_{n-1}\, b_{n-2} \cdots b_1 b_0}_{\text{Integer part}} \quad \underset{\underset{\text{Radix point}}{\uparrow}}{\cdot} \quad \underbrace{b_{-1}\, b_{-2} \cdots b_{-m}}_{\text{Fraction part}}$$

1.5.1 Decimal Number System

- This system has **'base 10'**.
- It has 10 distinct symbols (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9).
- This is a positional value system in which the value of a digit depends on its position.
  - $\Rightarrow$ Let's we have $(453)_{10}$ is a decimal number

    then,

$$
\begin{array}{lll}
4 & 5 & 3 \\
\end{array}
$$
$$3 \times 10^0 = 3$$
$$5 \times 10^1 = 50$$
$$4 \times 10^2 = 400$$
Finally we get, $(453)_{10}$

     $\therefore$ We can say "3" is the least significant digit(LSD) and "4" is the most significant digit(MSD).

1.5.2 Binary Number System

- It has base '2' i.e. it has two base numbers 0 and 1 and these base numbers are called "Bits".
- In this number system, group of "Four bits" is known as "Nibble" and group of "Eight bits" is known as "Byte".

  i.e. | 4 bits = 1 Nibble;   8 bits = 1 Byte |

Binary to Decimal Conversion

A binary number is converted to decimal equivalent simply by summing together the weights of various positions in the binary number which contains **'1'**.

 Example - 1.5 The decimal number representation of 101101.10101 is

Solution:

$$(101101.10101)_2 = 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1}$$
$$+ 0 \times 2^{-2} + 1 \times 2^{-3} + 0 \times 2^{-4} + 1 \times 2^{-5}$$
$$= 32 + 0 + 8 + 4 + 0 + 1 + \frac{1}{2} + 0 + \frac{1}{8} + 0 + \frac{1}{32} = (45.65625)_{10}$$

Decimal to Binary Conversion

The integral decimal number is repeatedly divided by '2' and writing the remainders after each division until a quotient '0' is obtained.

Example - 1.6 Convert $(13)_{10}$ to binary.

Solution:

	Quotient	Remainder	
$13 \div 2$	6	1	LSB
$6 \div 2$	3	0	
$3 \div 2$	1	1	
$1 \div 2$	0	1	MSB

∴ $(13)_{10} \Rightarrow (1101)_2$

Remember ▶

To convert Fractional decimal into binary, Multiply the number by '2'. After first multiplication integer digit of the product is the first digit after binary point. Later only fraction part of the first product is multiplied by 2. The integer digit of second multiplication is second digit after binary point, and so on. The multiplication by 2 only on the fraction will continue like this based on conversion accuracy or until fractional part becomes zero.

Example - 1.7 Convert $(0.65625)_{10}$ to an equivalent base-2 number.

Solution:

$$\begin{array}{ccccc}
0.65625 & 0.31250 & 0.62500 & 0.25000 & 0.50000 \\
\times 2 & \times 2 & \times 2 & \times 2 & \times 2 \\
\hline
1.31250 & 0.62500 & 1.25000 & 0.50000 & 1.00000 \\
\downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\
1 & 0 & 1 & 0 & 1
\end{array}$$

Thus, $(0.65625)_{10} = (0.10101)_2$

1.5.3 Octal Number System

- It is very important in digital computer because by using the octal number system, the user can simplify the task of entering or reading computer instructions and thus save time.
- It has a base of '8' and it posses 8 distinct symbols (0,1,...,7).
- It is a method of grouping binary numbers in group of three bits.

Octal to Decimal Conversion

An octal number can be converted to decimal equivalent by multiplying each octal digit by its positional weightage.

Example - 1.8 Convert $(6327.4051)_8$ into its equivalent decimal number.

Solution:

$$(6327.4051)_8 = 6 \times 8^3 + 3 \times 8^2 + 2 \times 8^1 + 7 \times 8^0 + 4 \times 8^{-1} + 0 \times 8^{-2} + 5 \times 8^{-3} + 1 \times 8^{-4}$$

$$= 3072 + 192 + 16 + 7 + \frac{4}{8} + 0 + \frac{5}{512} + \frac{1}{4096}$$

$$= (3287.5100098)_{10}$$

Thus, $(6327.4051)_8 = (3287.5100098)_{10}$

Decimal to Octal Conversion

- It is similar to decimal to binary conversion.
- For integral decimal, number is repeatedly divided by '8' and for fraction, number is multiplied by '8'.

Example - 1.9 Convert $(3287.5100098)_{10}$ into octal.

Solution:

For integral part:

	Quotient	Remainder
$3287 \div 8$	410	7
$410 \div 8$	51	2
$51 \div 8$	6	3
$6 \div 8$	0	6

$\therefore \qquad (3287)_{10} = (6327)_8$

Now for fractional part:

0.5100098	0.0800784	0.6406272	0.1250176
× 8	× 8	× 8	× 8
4.0800784	0.6406272	5.1250176	1.0001408
4	0	5	1

$\therefore \qquad (0.5100098)_{10} = (0.4051)_8$

Finally, $\qquad (3287.5100098)_{10} = (6327.4051)_8$

Octal-to-Binary Conversion

This conversion can be done by converting each octal digit into binary individually.

Example - 1.10 Convert $(472)_8$ into binary

Solution:

$$\begin{array}{ccc} 4 & 7 & 2 \\ \Downarrow & \Downarrow & \Downarrow \end{array}$$

$\therefore \qquad (472)_8 = (100 \quad 111 \quad 010)_2$

Binary-to-Octal Conversion

In this conversion the binary bit stream are grouped into groups of three bits starting at the LSB and then each group is converted into its octal equivalent. After decimal point grouping start from left.

Example - 1.11 Convert $(1011011110.11001010011)_2$ into octal.

Solution:

For left-side of the radix point, we grouped the bits from LSB:

$$\underbrace{0\,0\,1}_{1} \quad \underbrace{0\,11}_{3} \quad \underbrace{0\,11}_{3} \quad \underbrace{110}_{6}$$

Here two 0's at MSB are added to make a complete group of 3 bits.

For right-side of the radix point, we grouped the bits from MSB:

$$\overset{\uparrow}{\underset{\text{radix point}}{\bullet}} \quad \underbrace{110}_{6} \quad \underbrace{010}_{2} \quad \underbrace{100}_{4} \quad \underbrace{110}_{6}$$

Here a '0' at LSB is added to make a complete group of 3 bits.

Finally, $\qquad (1011011110.11001010011)_2 = (1336.6246)_8$

1.5.4 Hexadecimal Number System

- The base for this system is "16", which requires 16 distinct symbols to represent the numbers.
- It is a method of grouping 4 bits.
- This number system contains numeric digits (0, 1, 2,....9) and alphabets (*A, B, C, D, E* and *F*) both, so this is an "ALPHANUMERIC NUMBER SYSTEM".
- Microprocessor deals with instructions and data that use hexadecimal number system for programming purposes.
- To signify a hexadecimal number, a subscript 16 or letter '*H*' is used i.e. $(A7)_{16}$ or $(A7)_H$.

Hexadecimal	Decimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

Hexadecimal-to-Decimal Conversion

Example - 1.12 Convert $(3A.2F)_{16}$ into decimal system.

Solution:

$$(3A.2F)_{16} = 3 \times 16^1 + 10 \times 16^0 + 2 \times 16^{-1} + 15 \times 16^{-2}$$

$$= 48 + 10 + \frac{2}{16} + \frac{15}{16^2} = (58.1836)_{10}$$

Decimal-to-Hexadecimal Conversion

Example - 1.13 Convert $(675.625)_{10}$ into Hexadecimal.

Solution:
For Integral Part:

	Quotient	Remainder
$675 \div 16$	42	3
$42 \div 16$	2	10 = A
$2 \div 16$	0	2

$\therefore$ $\quad\quad\quad\quad\quad\quad (675)_{10} = (2A3)_{16}$

For fractional part:

$$0.625 \times 16 = 10 = A$$

$\therefore$ $\quad\quad\quad\quad\quad\quad (0.625)_{10} = (0.A)_{16}$

Finally, $\quad\quad\quad (675.625)_{10} = (2A3.A)_{16}$

Hexadecimal-to-Binary Conversion

For this conversion replace each hexadecimal digit by its 4 bit binary equivalent.

Example - 1.14 Convert $(2F9A)_{16}$ to Binary System

Solution:

$$\begin{array}{cccc} 2 & F & 9 & A \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 0010 & 1111 & 1001 & 1010 \end{array}$$

$\therefore$ $\quad\quad (2F9A)_{16} = (0010\,1111\,1001\,1010)_2$

Binary-to-Hexadecimal Conversion

For this conversion the binary bit stream is grouped into pairs of four (starting from LSB) and hexa number is written for its equivalent binary group.

Example - 1.15 Convert $(10100110101111)_2$ to hexadecimal number system.

Solution:

$$\underbrace{00\,10}_{2}\ \underbrace{10\,01}_{9}\ \underbrace{10\,10}_{A}\ \underbrace{1111}_{F}$$

Here two 0's at MSB are added to make a complete group of 4 bits.

$\therefore$ $\quad\quad (10100110101111)_2 = (29AF)_{16}$

NOTE

The number systems can also be classified as weighted binary number and unweighted binary number. Where weighted number system is a positional weighted system for example, Binary, Octal, Hexadecimal, *BCD*, 2421 etc. The unweighted number systems are non-positional weightage system for example Gray code, Excess-3 code etc.

1.6 Main Memory Organisation

The memory hierarchy was developed based on a program behavior known as locality of references. Memory references are generated by the CPU for either instruction or data access. These accesses tend to be clustered in certain regions in time, space, and ordering.

Main memory organisation
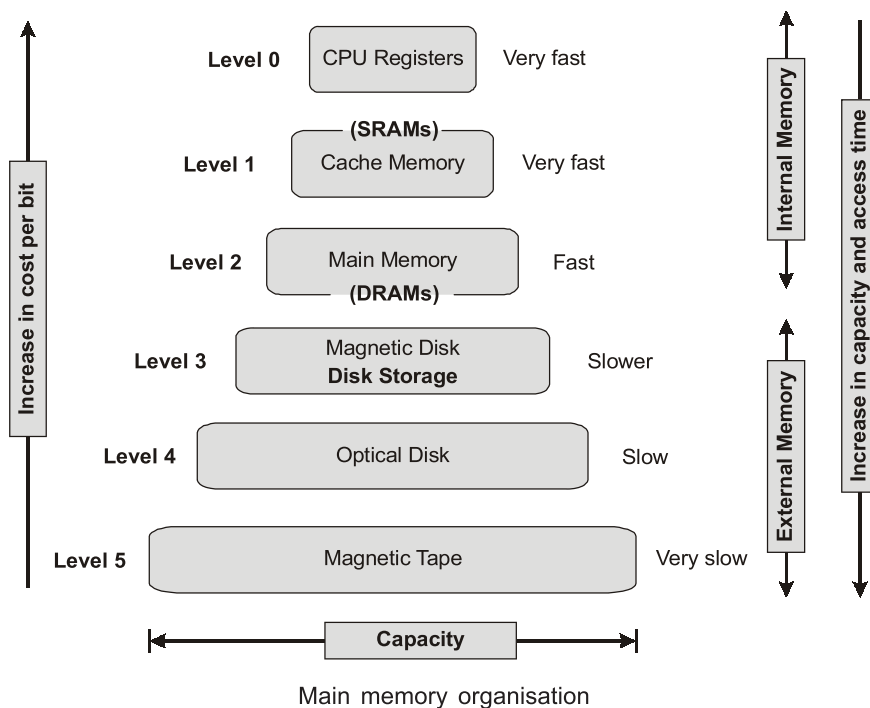
1.6.1 Types of Memory based on Access

1. **Serial Access Memory:** The system must search the storage device from the beginning of the memory address until it finds the required piece of data. Memory device which supports such access is called a Sequential Access Memory or Serial Access Memory.
   Example: Magnetic tape.

2. **Direct Access Memory:** Direct access memory or Random Access Memory, refers to condition in which a system can go directly to the information that the user wants. Memory device which supports such access is called a Direct Access Memory.
   Example: Magnetic disk and optical disks.

1.6.2 Memory Access Methods

1. **Sequential Access:** In this method, the memory is accessed in a specific linear sequential manner. For example, if fourth record (collection of data) stored in a sequential access memory needs to be accessed, the first three records must be skipped. Thus, the access time in this type of memory depends on the location of the data. Magnetic disks, magnetic tapes and optical memories such as CD-ROM use this method.

2. **Random Access:** In this mode of access, any location of the memory can be accessed randomly. In other words, the access to any location is not related with its physical location and is independent of other locations. For random access, a separate mechanism is therefore used as each location. Semiconductor memories (RAM, ROM) are this type.

3. **Direct Access:** This method is basically the combination of previous two methods. Memory devices such as magnetic hard disks contain many rotating storage tracks. If each track has its own read/write head, the tracks can be accessed randomly, but access within each track is sequential. In this case the access is semi-random or direct. The access time depends on both the memory organization and the characteristic of storage technology.
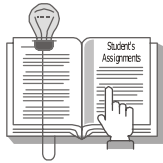
Student's Assignment

Q.1 In 8085 microprocessor unit scratch pad memory comprises of
(a) *B*, *C*, *D*, *E*, *H* and *L* Registers
(b) *W*, *Z*, *B*, *C*, *D*, *E*, *H* and *L* Registers
(c) *W*, *Z*, *B*, *C*, *D* and *E* Registers
(d) *W*, *Z*, *B*, *C*, *D*, *E*, *H*, *L* and status Registers

Q.2. An interrupt in which the external device supplies its address as well as the interrupt request is known as
(a) vectored interrupt
(b) maskable interrupt
(c) polled interrupt
(d) non-maskable interrupt

Q.3 **Assertion (A):** The data bus and address bus of 8085 microprocessor are multiplexed.
Reason (R): Multiplexing reduces number of pins.
(a) Both A and R are correct and R is correct explanation of A.
(b) Both A and R are correct but R is not correct explanation of A.
(c) Only A is correct.
(d) Only R is correct.

Q.4 **P :** Program counter is the register which stores the address of the next instruction to be executed.
Q : Stack pointer stores the address of the top of the stack.
Out of these two statements, which statement/s is/are true?
(a) Only P
(b) Only Q
(c) Both P and Q
(d) None of them

Q.5 How many instructions does microprocessor 8085?
(a) 255
(b) 256
(c) 246
(d) 250

Q.6 How many nibbles are there in 1 kbyte data?
(a) 500
(b) 1024
(c) 2048
(d) none of these

Q.7 The items that you can physically touch in a computer system are called:

(a) software
(b) firmware
(c) hardware
(d) none of the above

Q.8 Single-bit indicators that may be set or cleared to show the results of logical or arithmetic operations are the:
(a) flags
(b) registers
(c) monitors
(d) decisions

Q.9 When referring to instruction words, a mnemonic is
(a) a short abbreviation for the operand address.
(b) a short abbreviation for the operation to be performed.
(c) a short abbreviation for the data word stored at the operand address.
(d) shorthand for machine language.

Q.10 The technique of assigning a memory address to each I/O device in the computer system is called:
(a) memory-mapped I/O
(b) ported I/O
(c) dedicated I/O
(d) wired I/O

Q.11 When was the first 8-bit microprocessor introduced?
(a) 1969
(b) 1974
(c) 1979
(d) 1985

Q.12 What type of circuit is used at the interface point of an output port?
(a) Decoder
(b) Latch
(c) Tristate buffer
(d) None of the above

Q.13 I/O mapped systems identify their input/output devices by giving them a/an _____.
(a) 8-bit port number
(b) 16-bit port number
(c) 8-bit buffer number
(d) 8-bit instruction

Q.14 What type of circuit is used at the interface point of an input port?
(a) Decoder
(b) Latch
(c) Tristate buffer
(d) None of the above

Q.15 The register in the 8085 A that is used to keep track of the memory address of the next op-code to be run in the program is the:
  (a) stack pointer   (b) program counter
  (c) instruction pointer (d) accumulator

Q.16 All computer programs for a machine are called:
  (a) Software   (b) Firmware
  (c) Hardware   (d) None of the above

Q.17 The 8085A is a(n):
  (a) 16-bit parallel CPU
  (b) 8-bit serial CPU
  (c) 8-bit parallel CPU
  (d) none of the above

Q.18 Since microprocessor CPUs does not understand mnemonics therefore, they have to be converted to _____.
  (a) hexadecimal machine code
  (b) binary machine code
  (c) assembly language
  (d) all of the above

Q.19 A register in the microprocessor that keeps track of the answer or results of most of arithmetic or logic operation is the:
  (a) stack pointer   (b) program counter
  (c) instruction pointer (d) accumulator

Q.20 What is the difference between a mnemonic code and machine code?
  (a) There is no difference.
  (b) Machine codes are in binary, mnemonic codes are in shorthand English.
  (c) Machine codes are in shorthand English, mnemonic codes are in binary.
  (d) Machine codes are in shorthand English, mnemonic code are in special character.

Q.21 Which bus is a bidirectional bus?
  (a) Address bus
  (b) Data bus
  (c) Address bus and data bus
  (d) None of the above

Q.22 INTEL 8085 is a
  (a) 16 bit μp   (b) 8 bit μp
  (c) 4 bit μp   (d) 32 bit μp

Q.23 Internal memory of 8085 is
  (a) 64 KB
  (b) 0 KB
  (c) Can be of any size
  (d) None

Q.24 If a memory has 256 registers & 4 bits per location then the capacity of the memory is
  (a) 128 B   (b) 256 B
  (c) 512 B   (d) 1 KB

Q.25 The data lines in 8085 processor are multiplexed with address lines
  (a) Correct   (b) Incorrect
  (c) Can't say   (d) None of these

Q.26 Result of most of the ALU operations in 8085 is stored in
  (a) ACC   (b) In any register
  (c) PC   (d) SP

Q.27 Consider the following statements comparing static RAM with dynamic RAM:
  1. In static RAM typical cell requires more number of transistors than dynamic RAM.
  2. Power consumption per bit of static RAM is less than that of dynamic RAM.
  Which of the above statements is/are correct?
  (a) 1 and 2 only   (b) 1 only
  (c) 2 only   (d) Neither 1 nor 2

Q.28 Consider the following register:
  1. Accumulator and B register
  2. B and C register
  3. D and E register
  4. H and L register
  Which of these 8-bit registers of 8085 microprocessor can be paired together to make a 16-bit register?
  (a) 1, 3 and 4   (b) 2, 3 and 4
  (c) 1 and 2   (d) 1, 2 and 3

Q.29 A memory system has a total of 8 memory chips each with 12 address lines and 4 data lines. The size of memory system is
  (a) 16 kB   (b) 32 kB
  (c) 48 kB   (d) 64 kB

Q.30 In 8085 microprocessor, the value of the most significant bit of the result following the execution of any arithmetic or Boolean instruction is stored in the
(a) Carry status flag
(b) Auxiliary carry status flag
(c) Sign status flag
(d) Zero status flag

Q.31 The address bus of Intel 8085 is 16 bit and hence the memory which can be accessed by this address bus is
(a) 1 kB
(b) 16 kB
(c) 32 kB
(d) 64 kB

Q.32 Which of the following is/are included in architecture of a computer?
1. Addressing mode, CPU
2. Instruction mode, data formats
3. Secondary memory, operating system.
(a) 1 and 2
(b) 3 and 1
(c) 2 and 3
(d) 3 only

Q.33 Which of the following statements is/are correct?
1. Bus is a group of wires carrying information.
2. Bus is needed to achieve reasonable speed of operation.
3. Bus can carry data or address.
4. A bus can be shared by more than one device.
(a) 1 only
(b) 1 and 2 only
(c) 2, 3 and 4 only
(d) 1, 2, 3 and 4

Q.34 The following register holds the instruction before it goes to decoder
(a) Control register
(b) Accumulator
(c) Address register
(d) Data register

Q.35 The 8085 has two registers known as primary data pointer. These are registers
(a) B and C
(b) D and E
(c) H and L
(d) C and D

Q.36 Which of the following register of 8085 microprocessor is not a part of programming model?
(a) Instruction register
(b) Memory address register
(c) Status register
(d) Temporary data register

Q.37 The computer program which converts statement written high level language to object code is known as
(a) Assembler
(b) Compiler
(c) Disassembler
(d) Operating system

Q.38 In an assembler, which of the following is required for variable name in symbol table?
(a) Address
(b) Values
(c) Register
(d) Storage

Q.39 Which of the following is incorrect for a microprocessor?
1. It has ALU, CU and register.
2. It has interfacing circuits, timers.
3. It has internal memory.
(a) 1 and 2
(b) 2 and 3
(c) 1 only
(d) 1, 2 and 3

Q.40 A processor has 36 address lines. What is the maximum memory that can be connected or interfaced?
(a) 32 MB
(b) 64 MB
(c) 32 GB
(d) 64 GB

Q.41 Microcontroller is/are used in
(a) automobile engine control system
(b) implantable medical devices
(c) remote control office machine, power tools
(d) all of the above are correct

Q.42 Which of the following statements is/are correct about programmable logic controller (PLC)?
1. PLC is a specialized computer used to control machines and process.
2. The PLC uses a programmable memory to store/save instructions and specific functions that include ON/OFF control counting, arithmetic, timing, sequencing and also data handling.
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q.43 Which of the following are the advantage of programmable logic controller (PLC)?
1. It is flexible
2. It has faster response time
3. It has no moving parts
4. It is expensive
(a) 1, 2 and 3
(b) 1, 3 and 4
(c) 2, 3 and 4
(d) 1, 2, 3 and 4

Q.44 Which of the following bus is uni-directional bus?
1. Address bus
2. Data bus
3. Control bus
(a) 1 and 2 only   (b) 1 and 3 only
(c) 1 only   (d) 2 only

Q.45 Which of the following interrupt is a non-maskable interrupt.
(a) RST 7.5   (b) RST 6.5
(c) RST 5.5   (d) TRAP

Q.46 Which of the following is/are 16 bit register?
1. Stack pointer
2. Program counter
3. Accumulator
4. 'B' register
(a) 1 and 4   (b) 1 and 3
(c) 2 and 4   (d) 1 and 2

Q.47 Which of the following is not a hardware interrupt?
(a) RST 6.5   (b) RST 6
(c) RST 5.5   (d) TRAP

Q.48 Which of the following is/are correct?
1. 8051 - microcontroller
2. 8086 - microprocessor 32 bit
(a) 1 and 2   (b) 1 only
(c) 2 only   (d) None of these

Q.49 An intepreter is
(a) Program which convert machine language into high level language.
(b) Program which convert a high level program into a machine language, reads the entire program and execute it.
(c) Program which translates a high level program into machine code, executes it and reaches one statement at a time executes and then goes to the next statements of the program.
(d) None of these

Q.50 Which one of the following is correct with respect to microcontrollers?
(a) Integration of a microprocessor with I/O interfaces and memory and other peripherals in a single IC chip
(b) A single very large scale integrated (VLSI) chip that contains programmable electronic components that perform control functions

(c) Digital circuits for data handling and computation
(d) The primary computation and system control operations

Q.51 Which one of the following statements is correct?
(a) Microprocessor is more suitable for general purpose and microcontroller is more suitable for special purpose and custom-built application.
(b) Microprocessor and microcontroller are suitable for general purpose application.
(c) Microprocessor and microcontroller are suitable for special purpose application.
(d) Microprocessor and microcontroller are suitable for special purpose and custom-built application.

Q.52 With reference to a microprocessor, RISC stands for
(a) Redefined Instruction Set Computer
(b) Reduced Instruction Set Computer
(c) Restructured Instruction Set Computer
(d) Regional Instruction Set Computer

Q.53 Which one of the following is not an addressing Mode in 8085?
(a) Immediate   (b) Indirect
(c) Register   (d) Segment

Q.54 Consider the following statements regarding Programming Logic Controller (PLC):
1. It was developed to replace the microprocessor.
2. Wiring between devices and relay contacts are done in its program.
3. Its I/O interface section connects it to external fields devices.
4. It requires extensive wiring in the application.
Which of the above statements are correct?
(a) 1 and 3   (b) 1 and 4
(c) 2 and 3   (d) 2 and 4

Q.55 Which one of the following ways will be adopted to store the program counter contents?
(a) Last-in-First-out (LIFO)
(b) First-in-First-out (FIFO)
(c) Last-in-Last-out (LILO)
(d) First-in-Last-out (FILO)

Q.56 Consider the situation where a microprocessor gives an output of an 8-bit work. This is fed through an 8-bit digital to analog converter to a control valve. The control valve require 6 V being fully open. If the fully open state is indicated by 11111111, the output voltage for change of 1-bit will be
(a) 0.061 V   (b) 0.042 V
(c) 0.023 V   (d) 0.014 V

Q.57 Alternative paths provided by vertical paths from main rung of a ladder diagram that is paths in parallel represents
(a) logical AND operation
(b) logical OR operation
(c) logical NOT operation
(d) logical NOR operation

Q.58 **Statement (I) :** The function of arithmetic logic unit (ALU) in microprocessor is to perform data manipulation.

Statement (II) : The status register is where data for an input to the arithmetic and logic unit is temporarily stored.
(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **NOT** the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

ANSWER KEY // STUDENT'S ASSIGNMENT

1. (a)	**2.** (c)	**3.** (a)	**4.** (c)	**5.** (c)
6. (c)	**7.** (c)	**8.** (a)	**9.** (b)	**10.** (a)
11. (b)	**12.** (b)	**13.** (a)	**14.** (c)	**15.** (b)
16. (a)	**17.** (c)	**18.** (b)	**19.** (d)	**20.** (b)
21. (b)	**22.** (a)	**23.** (a)	**24.** (a)	**25.** (b)
26. (a)	**27.** (a)	**28.** (b)	**29.** (a)	**30.** (c)
31. (d)	**32.** (a)	**33.** (d)	**34.** (a)	**35.** (c)
36. (d)	**37.** (b)	**38.** (c)	**39.** (b)	**40.** (d)
41. (d)	**42.** (c)	**43.** (a)	**44.** (c)	**45.** (d)
46. (d)	**47.** (b)	**48.** (b)	**49.** (c)	**50.** (a)
51. (a)	**52.** (b)	**53.** (d)	**54.** (c)	**55.** (a)
56. (c)	**57.** (b)	**58.** (c)		

HINTS & SOLUTIONS // STUDENT'S ASSIGNMENT

27. (a)

Static RAM
- Never refreshed
- Fast
- More expensive
- Require 4 or 6 transistor along with some wiring

Dynamic RAM
- Frequent refresh
- Slow
- Less expensive
- Require a transistor and a capacitor

28. (b)

8-bit register paired together to make 16 bit register are
B and C register
D and E register
H and L register
Note: Accumulator (A) and flag register can be clubbed together to form a 16 bit register called program status work (PSW).

29. (a)

Number of memory location in each chip = 2^{12}
Number of bits in each chip = $2^{12} \times 4$ bits
Total number of bits in memory system
$$= 8 \times 4 \times 2^{12} \text{ bits}$$
$$= 4 \times 2^2 \times 2^{10} \text{ bytes}$$
$$= 16\text{k bytes}$$

30. (c)

The flag register have five different flag bit as below:

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
S	Z	X	AC	X	P	X	CY

1. Sign flag (s)
2. Zero flag (z)
3. Auxiliary flag (AC)
4. Parity flag (P)
5. Carry flag (C)