Problem Solving using Python

Unit: 1

Problem Solving using Python

B. Tech. 1st Sem

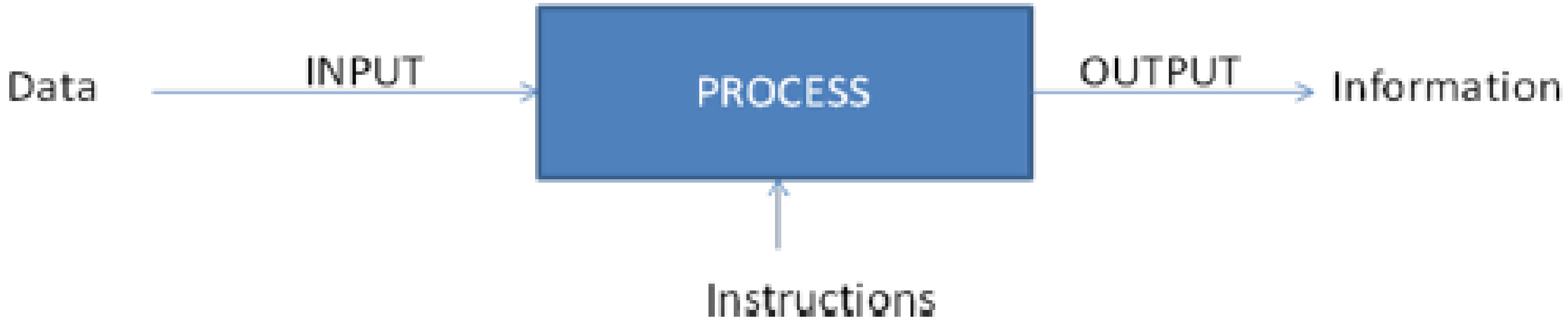
Ritesh Kumar Singh

NIET Gr. Noida

Computer Science

What is Computer?(CO1)

Computer - The term computer is derived from the term "compute". "Computer is a programmable electronic device that takes data and instruction as an input from the user and, process data, and provides useful information".



Some keys term that are frequently used in computer (CO1)

•**Data** is unprocessed facts and figures without any added interpretation or analysis.

•For e.g. “The price of crude oil is $80 per barrel”.

•**Information** is data that has been interpreted so that it has meaning for the user.

For e.g. “The price of crude oil has risen from $70 to $80 per barrel”.

•**Instruction** Commands given to the computer that tells what it has to do are instruction

•**Programs** A set of instruction that tell what is has to do are instruction

•**Software** A set of program is called software.

•**Hardware** A computer and all physical parts are known as hardware

History Of Computers

Computer Generations

There are five generations of computer:

- **First generation** – 1946 - 1958
- **Second generation** – 1959 - 1964
- **Third generation** – 1965 - 1970
- **Fourth generation** – 1971 - today
- **Fifth generation** – Today to future

History Of Computers

The First Generation

- The first computers used **vacuum tubes** for circuitry and **magnetic drums** for memory, and were often enormous, taking up entire rooms.
- They were very expensive to operate and in addition to using a great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.

Vacuum tube

History Of Computers

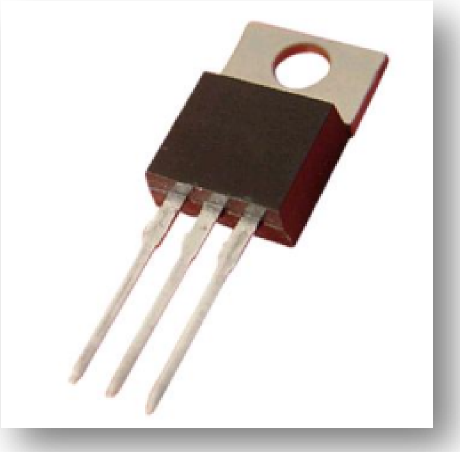
The First Generation

- First generation computers relied on machine language, the lowest-level programming language understood by computers, to perform operations, and they could only solve one problem at a time.
- Input was based on punched cards and paper tape, and output was displayed on printouts.
- Examples:
  - ENIAC
  - EDSAC
  - UNIVAC I, UNIVAC II, UNIVAC 1101

History Of Computers

The Second Generation

- Transistors replaced vacuum tubes and ushered in the second generation of computers.
- One transistor replaced the equivalent of **40 vacuum tubes**.
- Allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable.
- Still generated a great deal of heat that can damage the computer.



Transistor

History Of Computers

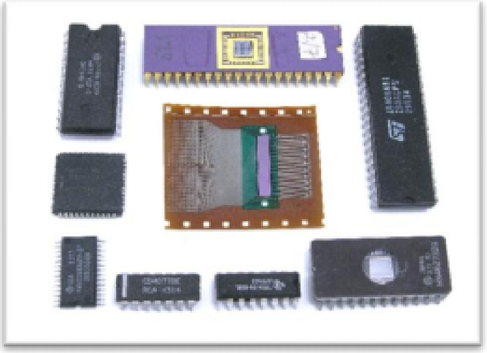
The Second Generation

- Second-generation computers moved from cryptic binary machine language to symbolic, or assembly, languages, which allowed programmers to specify instructions in words.
- Second-generation computers still relied on punched cards for input and printouts for output.
- These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology.
- Examples: **UNIVAC III, RCA 501, Philco Transact S-2000, NCR 300 series, IBM 7030 Stretch, IBM 7070, 7080, 7090 series**

History Of Computers

The Third Generation

- The development of the **integrated circuit** was the hallmark of the third generation of computers.
- Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers. It could carry out instructions in billionths of a second.
- Much smaller and cheaper compare to the second generation computers.



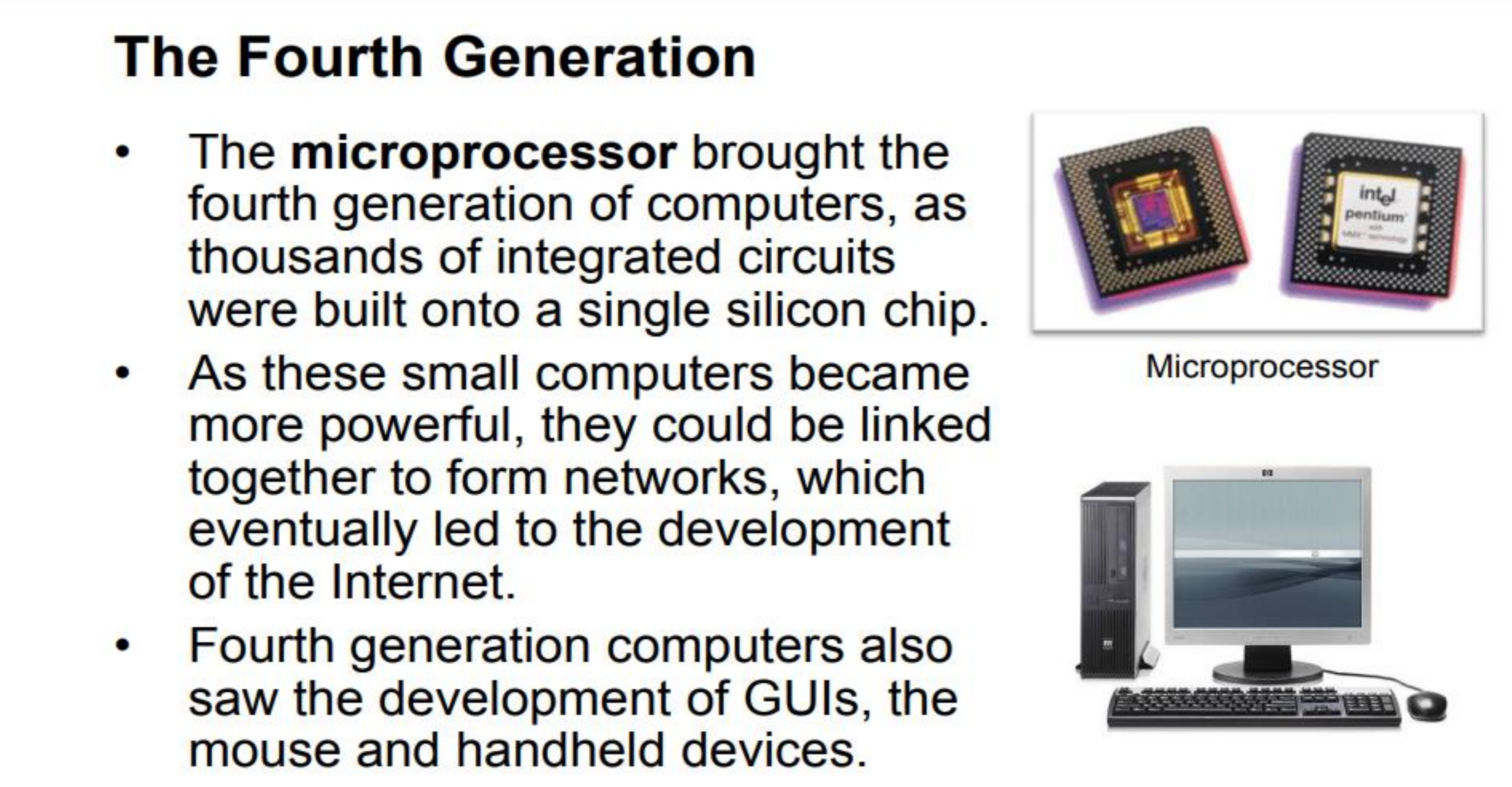
Integrated Circuit

History Of Computers

The Third Generation

- Users interacted with third generation computers through keyboards and monitors and interfaced with an operating system, which allowed the device to run many different applications at one time with a central program that monitored the memory.
- Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.
- Examples: **Burroughs 6700, Control Data 3300, 6600, 7600, Honeywell 200, IBM System/360, System 3, System 7**

History Of Computers



The Fourth Generation

- The **microprocessor** brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip.
- As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet.
- Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.

Microprocessor

History Of Computers

The Fifth Generation

- Based on Artificial Intelligence (AI).
- Still in development.
- The use of parallel processing and superconductors is helping to make artificial intelligence a reality.
- The goal is to develop devices that respond to natural language input and are capable of learning and self-organization.
- There are some applications, such as voice recognition, that are being used today.

Characteristics of a Computer(CO1)

- **Speed -** A computer is a fast device. A powerful computer is capable of performing several billions of arithmetic operations per second.

- **Accuracy -** Computers are accurate and depends upon its design.

- **Diligence -** It is free from monotony, tiredness and lack of concentration.

Characteristics of a Computer (Contd.) (CO1)

- **Versatility -** A computer is capable of performing almost any task, if the table can be reduced to a series of logical steps.

- **Storage -** A computer can store and recall any amount of information because of its secondary storage capability.

- **Automation -** It works on a problem without any human intervention. Once it started on a job, they carry on, until the job is finished.

Characteristics of a Computer (Contd.) (CO1)

- **No Feelings -** Computers have no emotion.

- **No I.Q.** - It possesses no intelligence of its own. Its IQ (intelligence quotient) is zero at least until today.

Applications of Computers(CO1)

- Word Processing
- Digital Audio/Video Compression
- Internet
- Desktop Publishing
- Traffic Control
- Retail Business
- Hospitals
- Business and Industry

Applications of Computers (Contd.) (CO1)

- Weather Forecasting
- Education
- Online Banking
- Robotics
- Expert Systems

Block Diagram of Digital Computers(CO1)

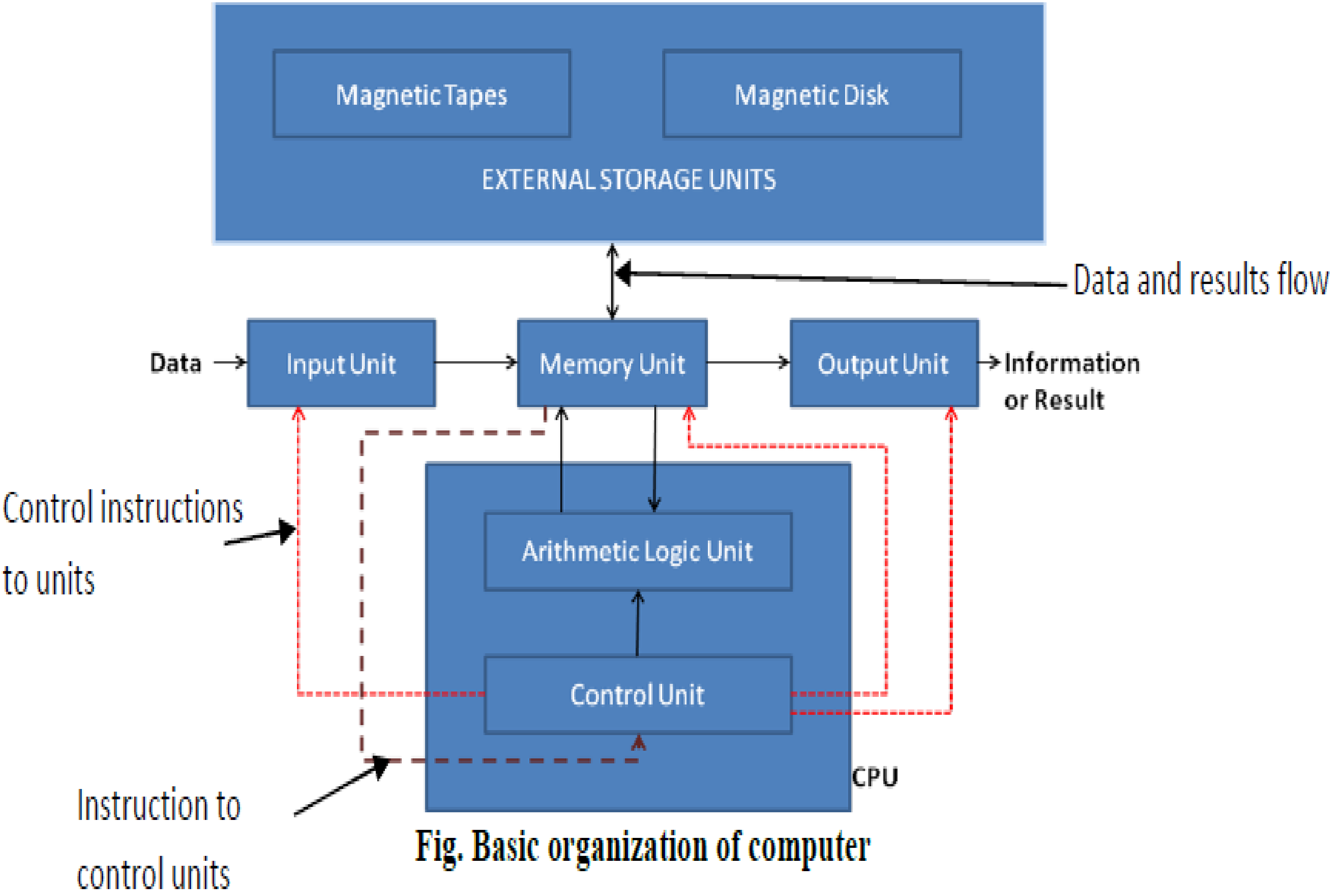


Fig. Basic organization of computer

Components of computer(CO1)

1. Input Devices -

- It accepts the instruction and data from the outside world.
- It converts these instruction and data in computer acceptable form.
- It supplies the converted instructions and data to the computer system for further processing.

Examples are ***Keyboard, Mouse, Scanner, Touch Screen, Joystick, Bar Code Reader, OMR (Optical Mark Recognition), MICR (Magnetic ink character recognition)***

Components of computer (Contd.) (CO1)

2. Output Devices -

- It accepts the results produced by the computer coded form.
- It converts these coded results to human understandable form.
- It supplies the converted result to the outside world.

Examples are ***Monitors, Printers, Speakers, Projectors, Plotters***

Components of computer (Contd.) (CO1)

3. **Memory unit** -

- It stores the data and instructions required for processing and stores intermediate results of processing.
- It also stores the final results of processing, before these results are released to an output device.
- It is mainly of 2 types –

i. Primary storage

ii. Secondary storage.

Components of computer (Contd.) (CO1)

4. CPU (Central Processing Unit) -

- It is the ***brain of a computer system***. It is responsible for activating and controlling the operations of other units of the computer system.
- It consists of –

i. Control unit (CU)

ii. Arithmetic Logic Unit (ALU)

Components of computer (Contd.) (CO1)

i. **Control Unit** -

It ***manages and coordinate*** entire computer system. It obtains instructions from program stored in main memory, interprets the instructions, and issues signals, which cause other units of the system to execute them.

ii. **Arithmetic Logic Unit (ALU)** -

It is the place ***where actual execution of the instructions takes place,*** during the processing operation. The data and instructions stored in the primary storage before processing, are transferred as when needed to the ALU. Processed data is transferred back to the main storage.

Daily Quiz 1

- Complete this equation:

  Data + ____________________ = Information

Answer: Meaning

- These are raw facts, figures, values or instructions with no specific meaning by themselves.

  (a) Information

  (b) Data

  (c) Meaning

Answer: b

Daily Quiz 1 (Contd.)

- The basic architecture of computer was developed by -

  A.John Von Neumann B.Charles Babbage

  C.Blaise Pascal D.Garden Moore

- Answer: B

- ***The basic operations performed by a computer are***

  A) Arithmetic operation

  B) Logical operation

  C) Storage and relative

  D) All the above

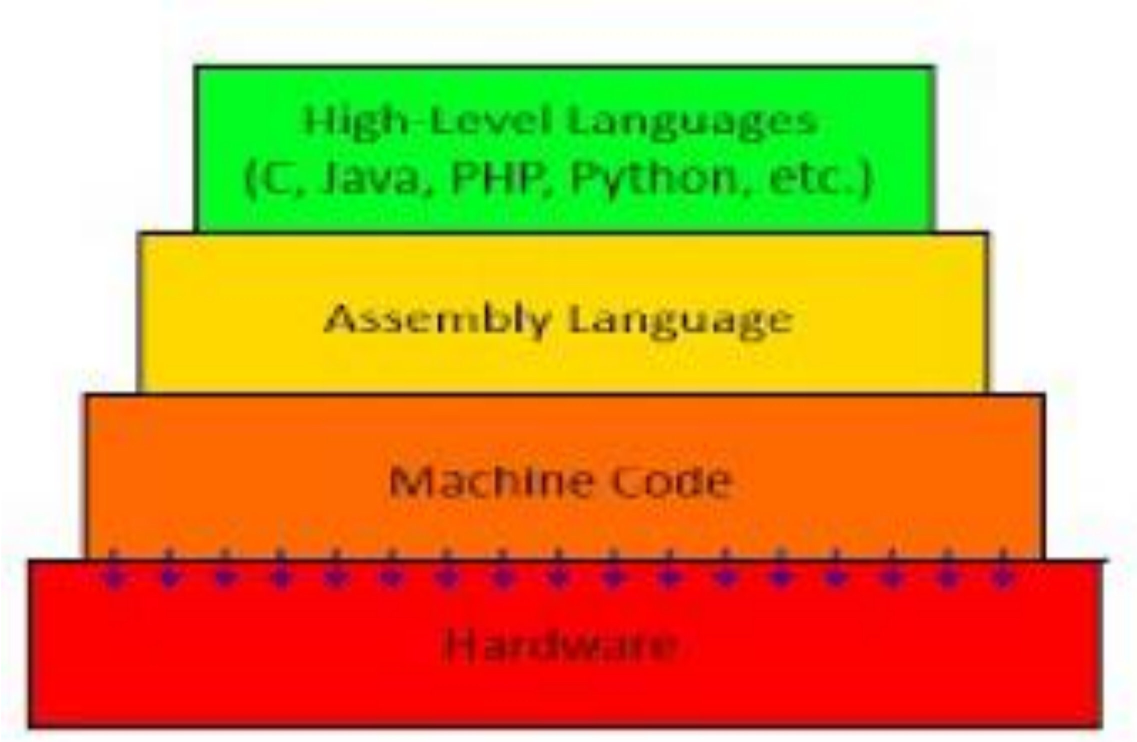
- Answer: D

Topic Objective

- After you have read and studied this topic, you should be able to
  - Understand the concept of computer program
  - Understand programming language
  - Understand the difference between machine language and High-level language
  - Understand the concept of assembly language

Type of Computer Languages (CO1)

- **Machine Language**
- **Assembly Language**
- **High level Language**



Machine Language (CO1)

Machine language is a collection of binary digits or bits that the computer reads and interprets.

- It is a low-level language.
- Instructions written in the form of 0 and 1.
- Machine language is the only language a computer is capable of understanding.
- Sometimes referred to as machine code or object code.
- Communicate directly with the computer.

Advantages

- Computation speed is very fast.
- Directly understandable by computer.

Disadvantages

- Writing a program is very time consuming.
- Error correction is a tedious process.

Assembly Language (CO1)

- It is also a low-level language.
- Written in the form of symbolic codes (mnemonics).
- Symbolic codes are like- ADD, SUB, MUL, DIV, LOAD, STORE, etc.
- Each assembly language is specific to a particular computer architecture.
- Assembly language is converted into executable machine code by a utility program referred to as an assembler.

Advantages

- Easier to understand as compared to machine code.
- Easy to locate and correct errors.

Disadvantages

- Like machine language it is also machine dependent.
- Programmer should have knowledge of hardware.

High Level Language (CO1)

A high-level language is a programming language that enables a programmer to write programs that are more or less independent of a particular type of computer.

- It is much closer to human language.
- It uses English words and/or mathematical notations.

Examples: COBOL, FORTRAN, PASCAL, C, C++, JAVA etc.

Advantages

- User-friendly.
- Require less time to code.
- Easier to learn.
- Easier to maintain.

Disadvantages

- Slower than low level language.
- Needs a translator.

Differentiate among Machine, Assembly and High level languages(CO1)

High level Language	Assembly Language	Machine Language
Programs of these languages are easily understandable.	These are less understandable than high level languages and more understandable than machine language.	Programs are less understandable
Programs of these languages are easily understandable.	These are less understandable than high level languages and more understandable than machine language.	Programs are less understandable.
Programs are portable and machine independent	Programs are machine dependent.	Programs are machine dependent.
In this language debugging is easier.	Debugging is more complex than high level languages.	Debugging is very difficult
Compiler or Interpreter is required to translate the program.	Assembler is required to translate the program	No translation is required

Generations of Programming Languages(CO1)

- **1GL** - Machine language.
- **2GL** - Assembly language.
- **3GL** - High level language (C, C++, JAVA, BASIC) (Procedural/object-oriented)
- **4GL** - Structured Query languages (SQL).
- **5GL** - Logic languages (LISP)

Topic Objective

- After you have read and studied this topic, you should be able to
  - Understand the concept of translator, compiler, interpreter and assembler
  - Understand the steps required in program execution
  - Understand the concept of linker and loader
  - Understand the difference between object code and executable code

Translators (CO1)

A translator is a software that translate any programming language to another programming language.

There are following three translators :

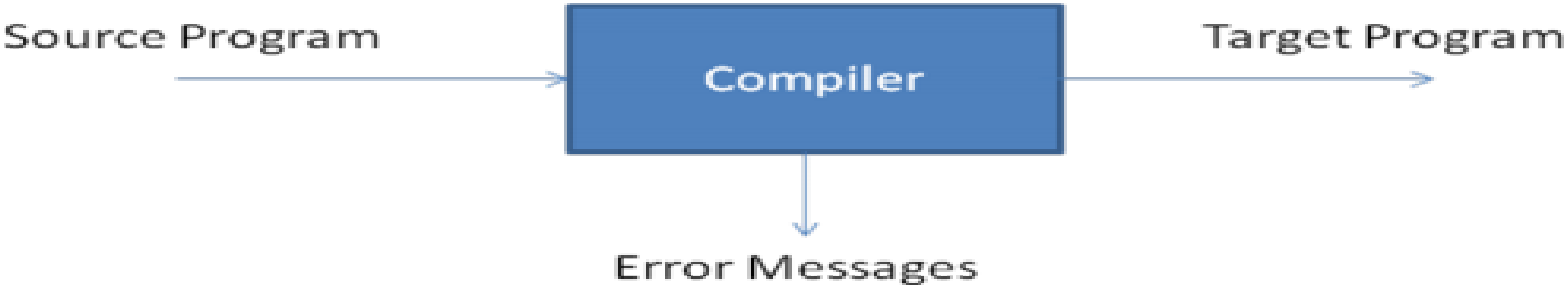
- – Assembler
- – Compiler
- – Interpreter

Compiler (CO1)

- ***Compiler is a special type of program that translate the source code written in high level language (source language) into the low-level language (target language).***

- The resultant code can be assembly code or the object code. It is used to create an executable program.

- It locates and reports syntax error in the program (if any). But it cannot fix the error by itself.



Assembler (CO1)

- It is a special program that translate the code written in assembly language into an equivalent code in machine language.
- The result is the object file that can be executed.

Interpreter (CO1)

- An interpreter is a computer program that directly executes without previously compiling them into a machine language program.
- ***It converts High level language into low level.***
- Interpreter is one which converts a source program and executes it at the same time.
- It translates line by line.

Difference between Interpreter and Compiler(CO1)

Interpreter	Compiler
Translated program one statement at a time	Scans the entire program and translates it as a whole into machine code
Takes less amount of time to analyze the source code but overall execution time is slower	Takes large amount of time to analyze the source code but overall execution time is comparatively faster.
No intermediate code generated	Generate intermediate code
Requires less memory	Requires more memory
Debugging is easy	Debugging is comparatively hard

Topic Objective

- After you have read and studied this topic, you should be able to
  - Understand the concept of algorithm and flowchart
  - Design algorithm for real-life problems
  - Convert algorithm into flowchart

Algorithm (CO1)

- An algorithm is a ***sequence of computational steps*** that transform the input into the output.
- An algorithm provides step by step solution of given problem.

Properties of good Algorithm /Characteristics of algorithm (CO1)

An algorithm must have the following properties:

(i) **Input** : An algorithm required input from the user

(ii) **Output**: An algorithm gives at least one output.

(iii) **Definiteness:** Each step must have a unique defined preceding and succeeding step.

(iv) **finiteness:** An algorithm should be terminated in finite no of steps

(v) **Effectiveness:** Each step must be effective i.e. it should be easily convertible into program

Flow Chart(CO1)

Flow chart is a graphical representation of a process. Each step in the process is represented by different symbols and contains the short description of the process step.

Flow Chart Symbols:

(1) **Terminator:** Terminator symbol is used to represent the beginning and end of a process.

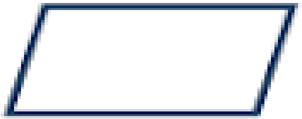
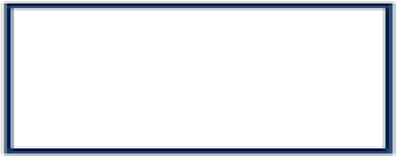
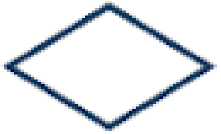
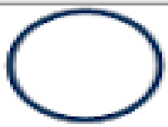
(2) **Process:** Process symbol is used to represent an activity.

(3) **Data:** A data symbol is used to represent input and output in a flow chart.

(4) **Decision:** A diamond shape is used to show the decision.

(5) **Connector Lines:** Connector lines are used to connect the symbols in a flow chart. The direction of arrow indicates the next step.

Flow Chart Symbols(CO1)

Symbol	Name	Function
	Start / End	Oval shape shows start or end.
	Input / output	Parallelogram shows input or output
	Action or Process	Rectangle represents process
	Decision	A diamond indicates a decision
	Arrows	Arrows shows flow direction
	Circle	Connector symbol

Pseudo Code(CO1)

- Pseudocode is an informal high-level description of the operating principle of a computer program.
- It uses the basic syntax of a normal programming language.
- It is human readable rather than machine readable.

Difference between Algorithm and Flow Chart(CO1)

Algorithm	Flow Chart
1. An algorithm is step by step procedure to solve a given problem.	1. Flow chart is pictorial representation of the flow of the program.
2. It is very easy procedure to represent logics in algorithm.	2. It is very complex to represent some logic's using flow chart due to lack of more symbols.
3. It is easy to modify algorithm.	3. It is very difficult to modify flow chart.

Difference between Algorithm and Pseudocode(CO1)

Algorithm	Pseudocode
1. An algorithm is a well-defined sequence of steps that provides a solution for a given problem.	1. A pseudocode is one of the methods that can be used to represent an algorithm.
2. An algorithm can be written in natural language	2. Pseudocode is written in a format that is closely related to high level programming language.
3. Transforming an algorithm in to programming code is difficult.	3. Converting a pseudo code in to programming code is easy.

Algorithm to find the sum of two numbers(CO1)

Step-1 Start

Step-2 Input first numbers say A

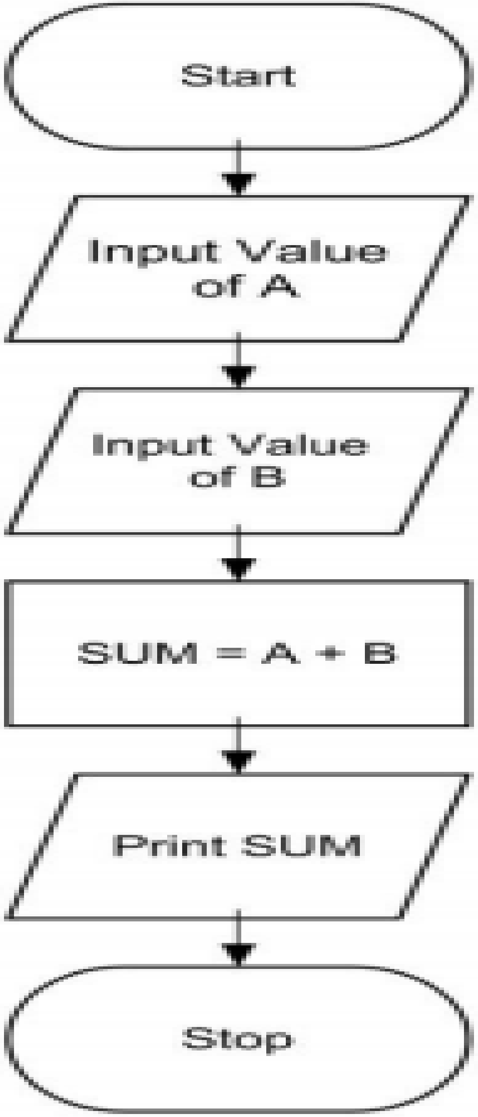
Step-3 Input second number say B

Step-4 SUM = A + B

Step-5 Display SUM

Step-6 Stop

Flowchart to find the sum of two numbers(CO1)



Algorithm to convert temperature from Celsius to Fahrenheit (CO1)

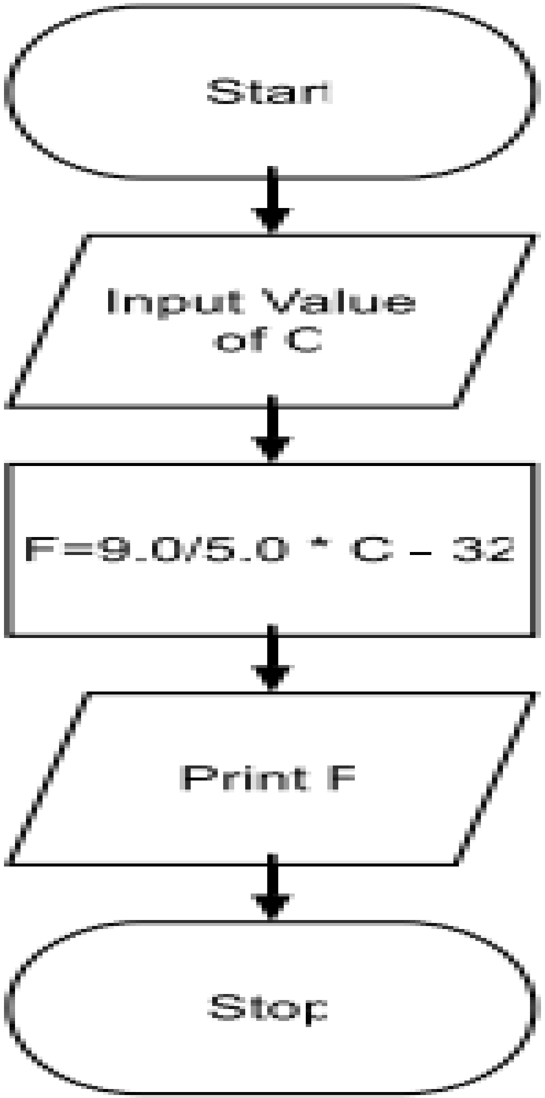
C : temperature in Celsius

F : temperature Fahrenheit

Algorithm

```
Step-1 Start
Step-2 Input temperature in Celsius say C
Step-3 $F = (9.0/5.0 x C) + 32$
Step-4 Display Temperature in Fahrenheit F
Step-5 Stop
```

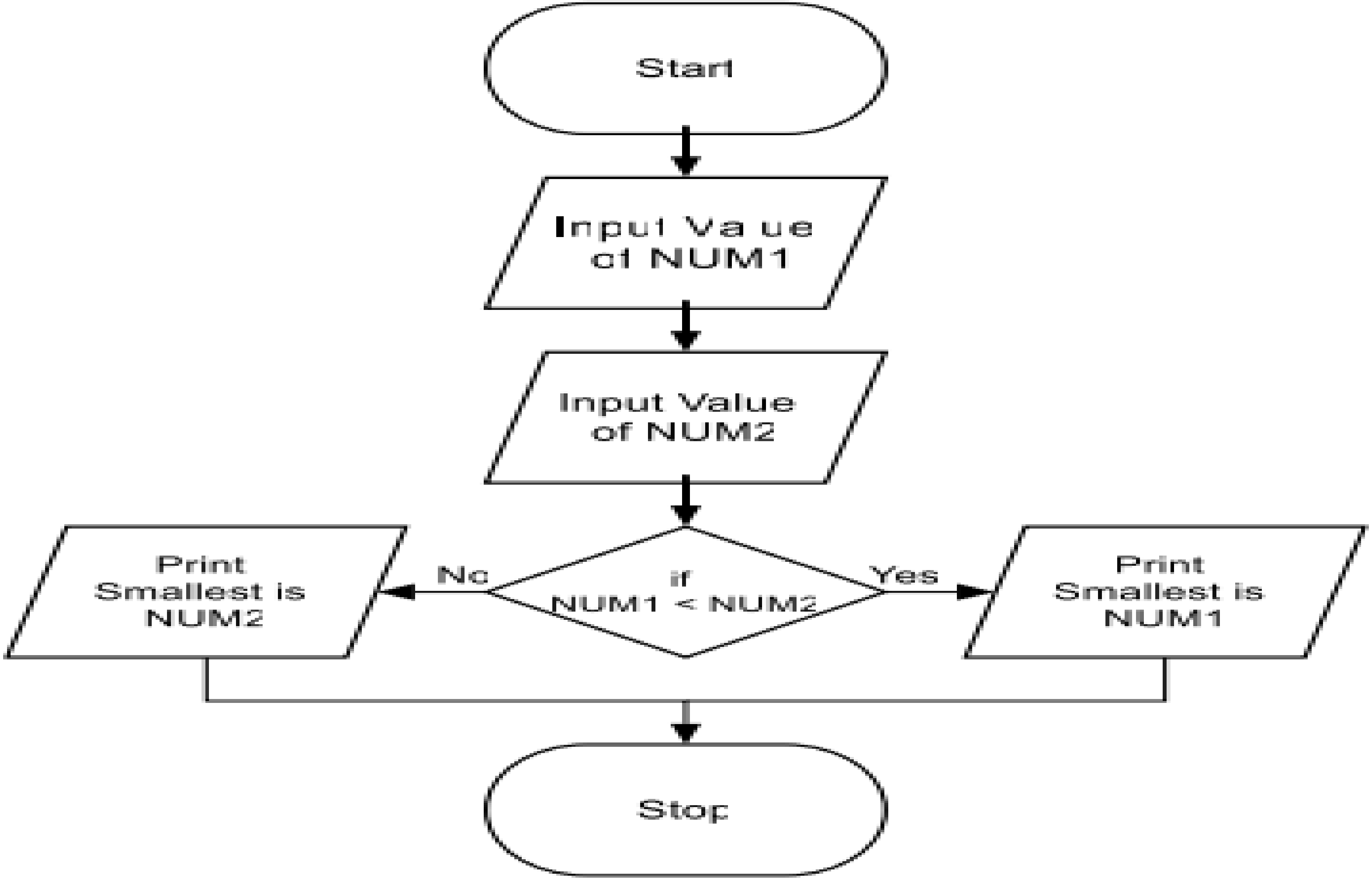
Flowchart to convert temperature from Celsius to Fahrenheit(CO1)



Algorithm to find the smallest of two numbers(CO1)

```
Step-1 Start

Step-2 Input two numbers say NUM1,NUM2

Step-3 IF NUM1 < NUM2 THEN

                print smallest is NUM1

        ELSE

                print smallest is NUM2 ENDIF

Step-4 Stop
```

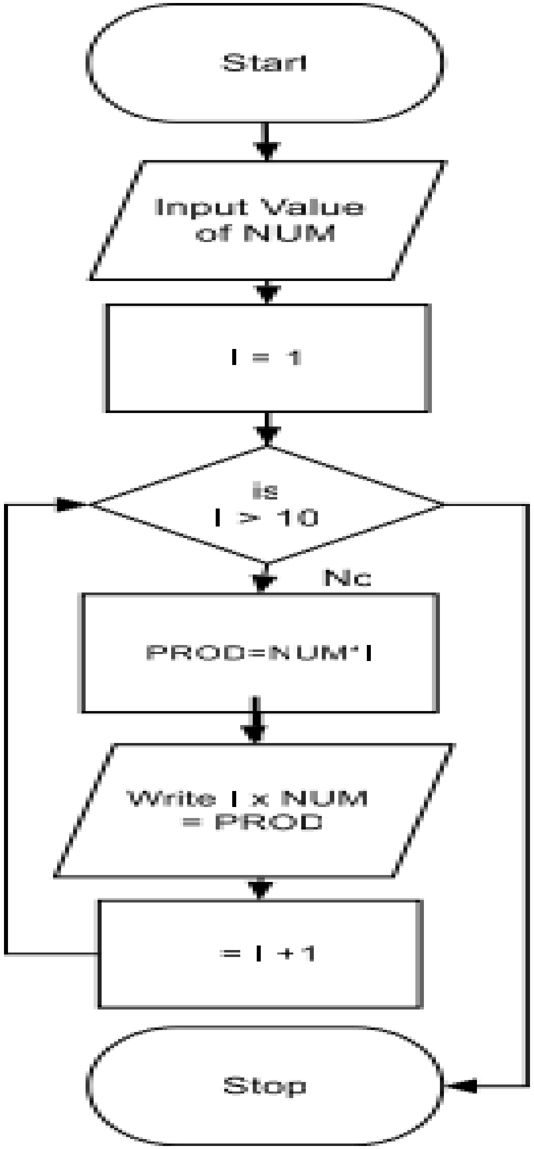
Flowchart to find the smallest of two numbers(CO1)



Algorithm to print multiplication Table of a number(CO1)

```
Step-1  Start
Step-2  Input Value of NUM
Step-3  I = 1
Step-4  IF (I >10) THEN
            GO TO Step 9
        ENDIF
Step-5  PROD = NUM * I
Step-6  WRITE I “x” NUM “=” PROD
Step-7  I = I + 1
Step-8  Go to step-4
Step-9  Stop
```

Flowchart to print multiplication Table of a number(CO1)



Daily Quiz 5

- What do you mean by High-level and low-level programming language?
- Define compiler, interpreter and assembler.
- Explain object code and executable code with example.
- Write down algorithm to find sum of digits of a given number.
- Explain Flowchart and symbols used in the flowchart.
- Draw flow chart to check given number is palindrome or not.
- write an algorithm and draw flowchart to check year is leap year or not

Weekly Assignment 2

Que 1 – Covert the following :

(a) $[10111001.0111]_2 = [\qquad]_{10}$

(b) $[582]_{10} = [\qquad]_{16}$

(c) $[2547]_8 = [\qquad]_2$

(d) $[78D1]_{16} = [\qquad]_2$

Que 2 - What is translator? Explain compiler, assembler, interpreter in detail.

Que 3 – Differentiate between Machine language, Assembly language and high-level programming language.

Que 4 – Write algorithm and draw a flowchart to check that enter number is even or odd.

Que 5 - Draw a flowchart to print the sum of sequence of alternative numbers between 1 to n.

You tube & NPTEL Video Links

- Youtube/NPTEL Video Links –
- https://nptel.ac.in/courses/106/105/106105171/
- https://nptel.ac.in/courses/106/104/106104128/
- https://www.youtube.com/channel/UC5o8kz8aQHIiFk23sJ9pxig

MCQs

1. Which is referred to the brain of computer?

A: Processor

B: RAM

C: ROM

D: Hard drive

Answer 1 : a

2. What is the name of programs that control the computer system?

A: Hardware

B: Keyboard

C: Software

D: Mouse

Answer 2 : c

MCQs

3. What is the common measurement of unit of a computer memory?

A: IQ B: Byte

C: Terabyte D: Gigabyte

Answer 3 : b

4. The decimal equivalent of (0.101)2 will be ______________

a) 0.5 b) 0.625

c) 0.25 d) 0.875

Answer 4 : b

MCQs

5. The program written by the programmer in high level language is called ___________

a) Object Program b) Source Program

c) Assembled Program d) Compiled Program

Answer 5 : b

6. Which of the following is the fastest means of memory access for CPU?

a) Registers b) Cache

c) Main memory d) Virtual Memory

Answer 6: a

MCQs

7. These devices provide a means of communication between a computer and outer world.

a) I/O b) Storage

c) Compact d) Drivers

Answer 7: a

8. What does GUI stand for?

a) Graphical User Instruction

b) Ground User Interface

c) General User Instruction

d) Graphical User Interface

Answer 8: d

MCQs

9. When an algorithm is written in the form of a programming language, it becomes a ___________

a) Flowchart b) Program

c) Pseudo code d) Syntax

Answer 9: b

10. In computer science, algorithm refers to a pictorial representation of a flowchart.

a) True b) False

Answer 10: b

Old University Exam Question Papers

Que – Draw the block diagram of a computer system. Explain its different components with suitable example.

[AKTU 2018-19 (Even) Marks-10]

Que – Write an algorithm and draw a flowchart to find the sum of digits of an integer number entered by the user.

[AKTU 2018-19 (Even) Marks-10]

Que – Write an algorithm and draw a flowchart to reverse an integer number entered by the user.

[AKTU 2018-19 (Even) Marks-10]

Que - Discuss the concept of assembler. Explain complier, interpreter, loader and linker with example.

[AKTU 2018-19 (Even) Marks-10]

Old University Exam Question Papers

Que – Describe the basic components of a computer system with neat and clean block . What do you mean by operating system? Explain. [AKTU 2018-19 (Odd) Marks-10]

Que – What is algorithm? What are the main steps followed in the development of an algorithm? Write an algorithm for sum of digits in a given number.

[AKTU 2017-18 (Even) Marks-07]

Que – Describe Compiler, interpreter, assembler? Write the names of compiler that are used in c programming.

[AKTU 2017-18 (Even) Marks-07]

Que – Differentiate complier and interpreter.

[AKTU 2017-18 (odd) Marks-02]

Old University Exam Question Papers

Que – Convert the following:

(i) (0110110.1100)2 = ()8

(ii) (74.67)10 = ()16

(iii)(AB.CD)16 = ()8

(iv)(EFE.45)16 = ()2

(v) (576.4)10 = ()6

(vi)(1234.7)8 = ()16

(vii)(334.43)8 = ()2

[AKTU 2017-18 (Even) Marks-07]

Expected Questions for University Exam

- Draw the block diagram of a digital computer system. Explain its different components with suitable example.
- Explain memory hierarchy with suitable diagram.
- What is Operating System? Explain functions and types of operating system in detail.
- Describe Compiler, interpreter, assembler? Also differentiate among them.
- Write an algorithm and draw a flowchart to find the greatest among three numbers.
- Draw flow chart to check given number is palindrome or not.

Summary

- “Computer is a programmable electronic device that takes data and instruction as an input from the user and, process data, and provides useful information”.
- Data is unprocessed facts and Information is processed & meaningful data.
- CPU is the *brain of a computer system*. It is responsible for activating and controlling the operations of other units of the computer system.
- Computer memory is any physical device capable of storing information temporarily or permanently.

Summary (contd..)

- Software is defined as a computer program, which includes logical instructions used for performing a particular task on a computer system using hardware components.
- An operating system is a program that acts as an interface between the user and the computer hardware and controls the execution of all kinds of programs.
- A computer programming language is a language used to write computer programs, which involve a computer performing some kind of computation or algorithm.
- Machine language is a collection of binary digits or bits that the computer reads and interprets.

Summary (contd..)

- Assembly language is written in the form of symbolic codes (mnemonics).
- A high-level language is a programming language that enables a programmer to write programs that are more or less independent of a particular type of computer.
- Compiler is a special type of program that translate the source code written in high level language (source language) into the low-level language (target language).
- Interpreter converts High level language into low level.
- An algorithm provides step by step solution of given problem.
- Flow chart is a graphical representation of a process.

Thank You