4. 1 Classification of Programming Languages

A "programming language" is a language designed to describe a set of actions to be executed by a computer. A "programming language" is a practical way for us (humans) to give instructions to a computer. Programming languages can be classified into (See Figure 1)

1. Machine Language (Low-level language): uses 0's and 1's for coding the

instructions. It is used in 1st generation computers.

2. Assembly Language: is an English-like terms representing binary code. It uses mnemonics like ADD for addition and SUB for subtraction ...etc. It is easier to write instructions in assembly language, as compared to writing instructions in machine language. It is used in 2nd generation computers.

3. High-level language: High-level language has a major advantage over machine and assembly languages that it is easy to learn and use because it is closer to human language
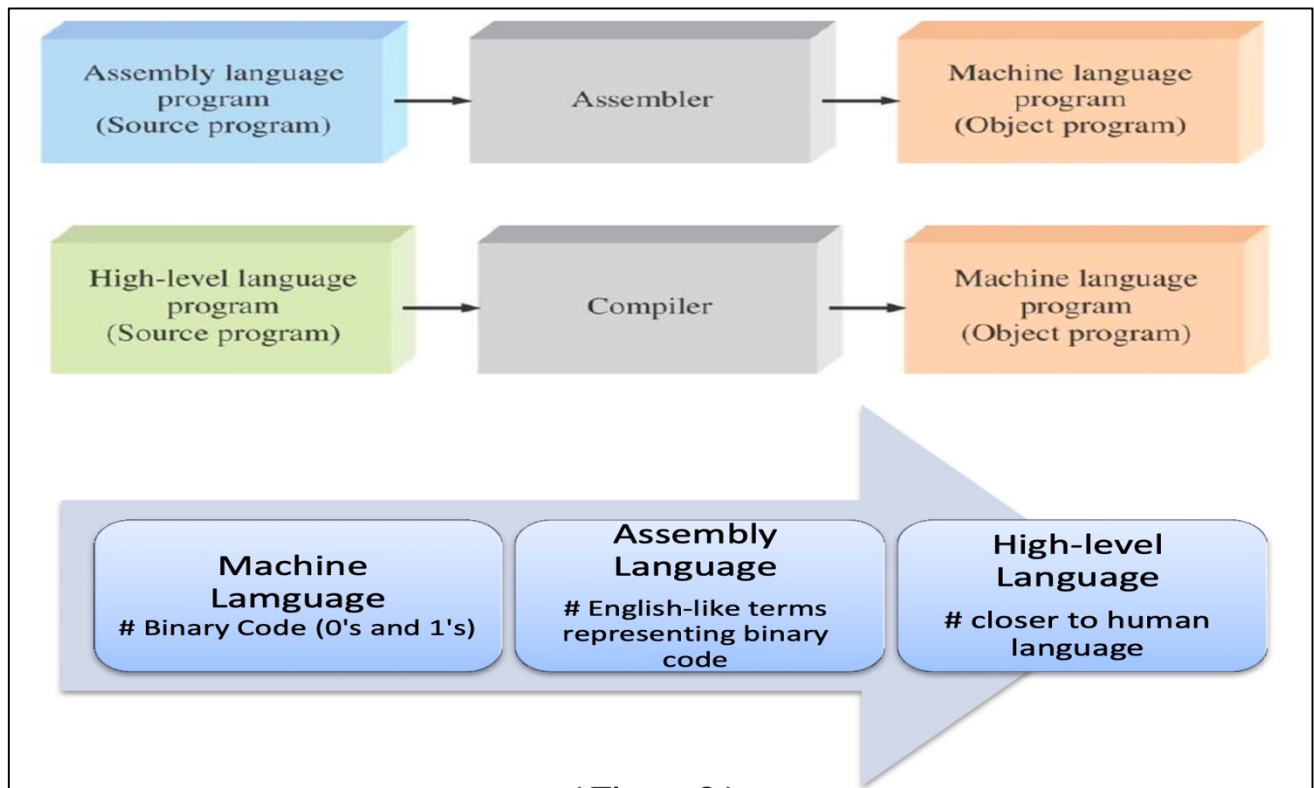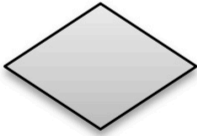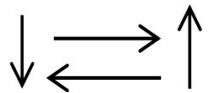

Figure 1

4.2 Algorithms and Flowcharts

- An **algorithm** is a procedure consisting of a set of rules (instructions) provides the solution to a problem. In other word, an algorithm is a step by-step procedure to solve a given problem.

- A **flowchart** is a diagram made up of boxes, diamonds and other shapes, connected by arrows , each shape represents a step in the process.

Flowchart Symbols

There are 6 basic symbols commonly used in flowcharting programs:

Symbol	Name	Function
	Start / End	Indicates the starting or ending of the program, process, or interrupt program.
	Input / Output	Used for any Input/Output (I/O) operation. Indicates that the computer is to receive data or output results.
	Process	Indicates any type of internal operation inside the Processor or Memory
	Decision	Used to ask a question that can be answered in a binary format (Yes/No, True/False)
	Connector	Allows the flowchart to be drawn without intersecting lines or without a reverse flow.
	Flow Lines (Arrows)	Shows direction of flow.

Decision (*if … else*)
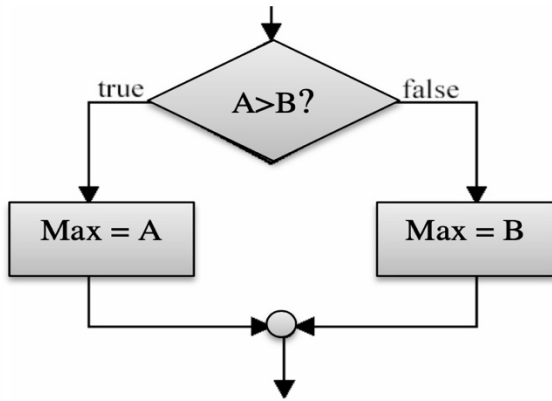
Repetition (loop)
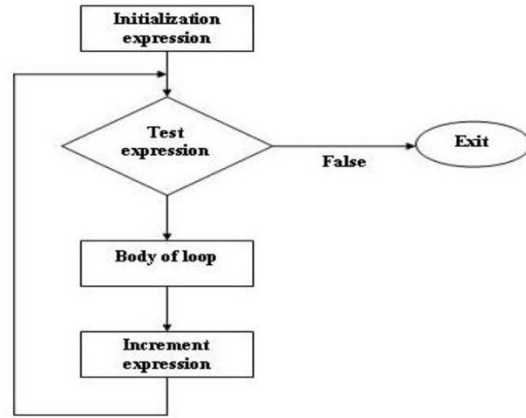
Ex: Draw a flowchart that reads the radius of a sphere "r", then it calculates its volume "V" and surface area "A" using formulas:

$$V = \frac{3}{4}\pi r^3 \quad , \quad A = 4\pi r^2$$

Ex: 6Ω, 3Ω resisters are connected in series across a 36v source, draw a flowchart to find the total current and the voltage of each resister.

17

Ex: Draw a flowchart to find the value of $y = \begin{cases} x+2 & x \geq 0 \\ x^2+2 & x < 0 \end{cases}$

```
                    ┌─────────┐
                    │  Start  │
                    └─────────┘
                         │
                   ╱───────────╲
                   │  Input  x  │
                   ╲───────────╱
                         │
  ┌─────────┐      ◇───────────◇      ┌───────────┐
  │ y = x+2 │◄─────│   x > 0 ?  │─────►│ y = x² + 2│
  └─────────┘      ◇───────────◇      └───────────┘
       │                 │                   │
       │               ( ○ )                 │
       └─────────────────┼───────────────────┘
                         │
                   ╱───────────╲
                   │  Print y   │
                   ╲───────────╱
                         │
                    ┌─────────┐
                    │   End   │
                    └─────────┘
```
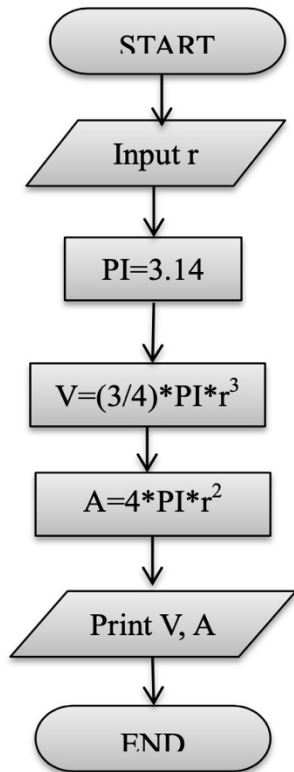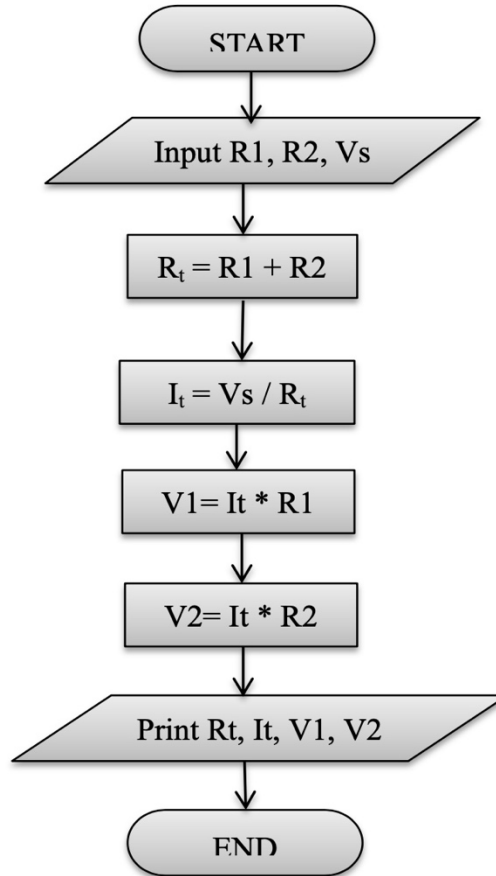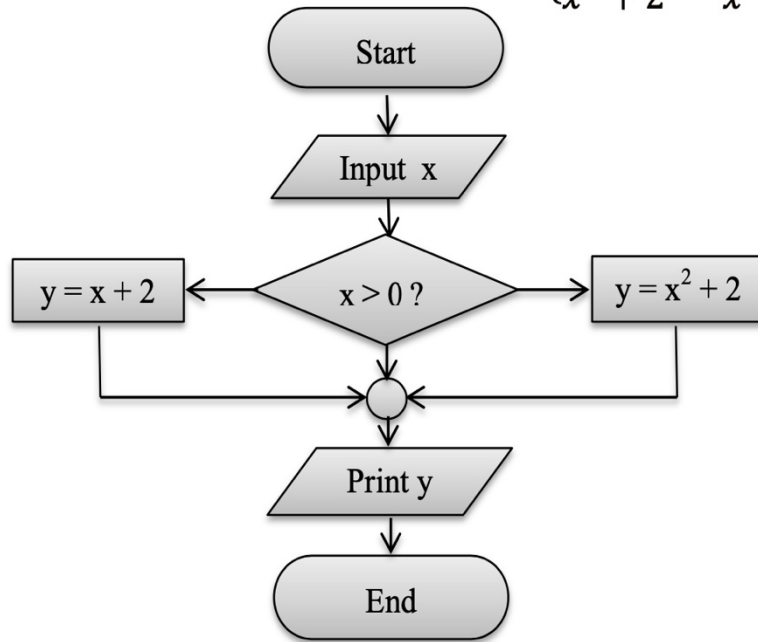
Ex: Draw a flowchart to find the largest of three numbers A, B, and C:

```
                         ┌─────────┐
                         │  Start  │
                         └─────────┘
                              │
                      ╱──────────────╲
                      │ Input  A, B, C│
                      ╲──────────────╱
                              │
  ◇─────────◇      ◇───────────◇      ◇───────────◇
  │ B > C ? │◄─────│   A > B ?  │─────►│   A > C ?  │
  ◇─────────◇      ◇───────────◇      ◇───────────◇
     │                   │                   │
 ╱───────╲         ╱───────╲                 ╱───────╲
 │Print B │        │Print C │                │Print A │
 ╲───────╱         ╲───────╱                 ╲───────╱
     │                 │                         │
     └─────────────────┼─────────────────────────┘
                       │
                  ┌─────────┐
                  │   End   │
                  └─────────┘
```

18
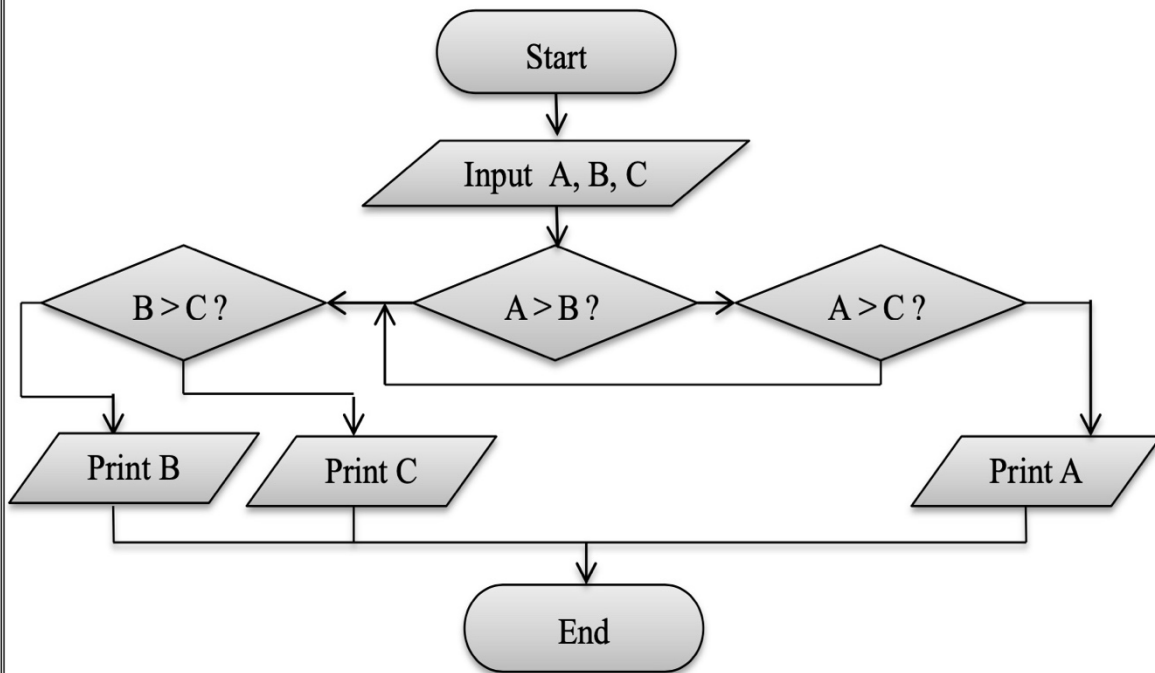
Ex: Draw a flowchart to find the sum of the first 25 odd natural numbers: Sum = 1 + 3+ 5 + ……

Start

i = 0

Sum = 0

i = i + 1

j = 1   j = j + 2

sum = sum + j

i =25 ?

Print sum

End
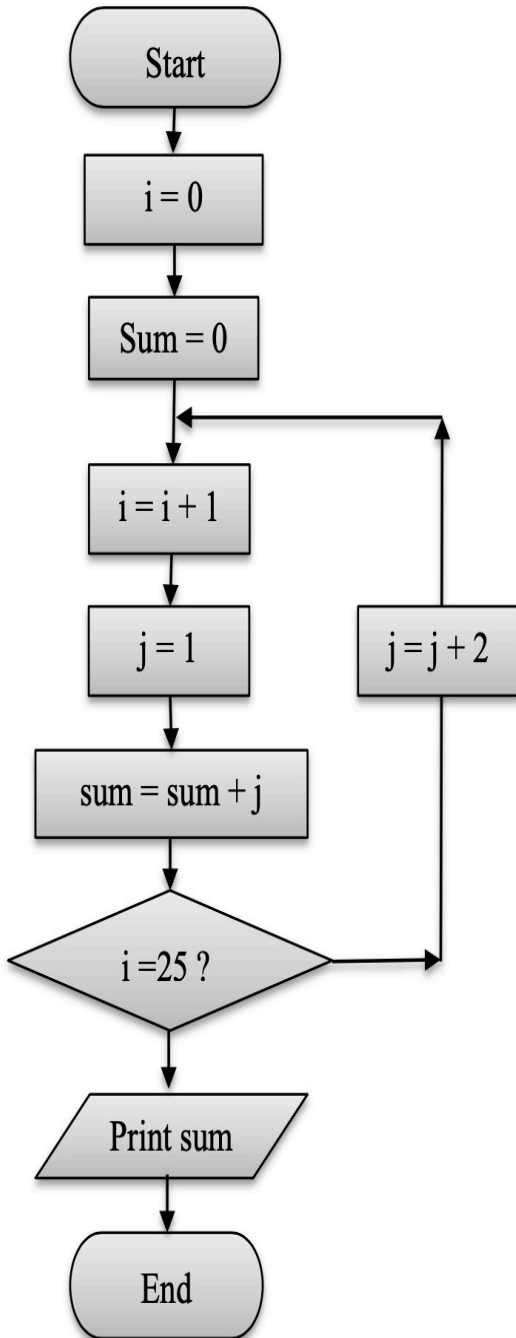
Ex: Draw a flowchart to find the sum of first 100 natural numbers: Sum = 1 + 2 + 3 + ……+ 99 + 100.

Start

i = 0

Sum = 0

i = i + 1

sum = sum + i

i =100 ?

Print sum

End
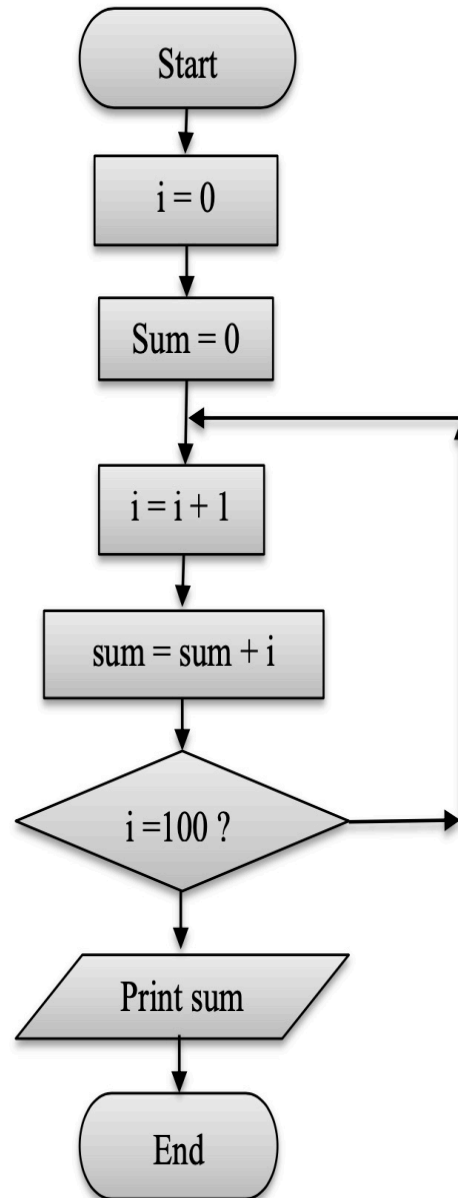
Ex: Draw a flowchart to solve an equation of second order given by:

$$a\,x^2 + b\,x + c = 0$$

START

Input a, b, c

$d = (b*b - 4*a*c)$

If d < 0

If d > 0

Print "complex roots"

X1 = –b / (2 * a)
X2 = –b / (2 * a)

X1 = (–b + sqrt(d)) / (2 * a)
X2 = (–b – sqrt(d)) / (2 * a)

Print X1, X2

END
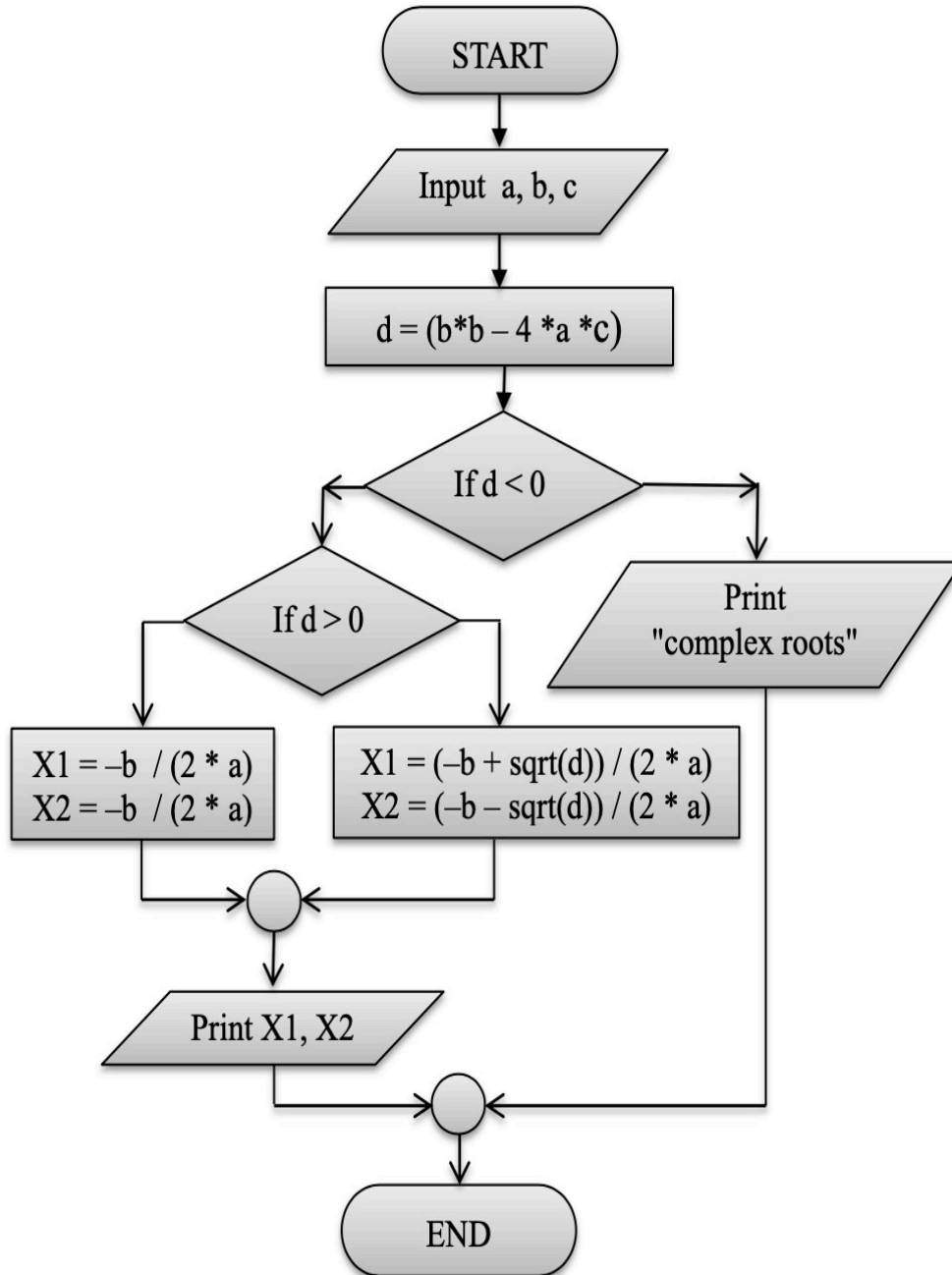
Ex: draw a flowchart to find the average of 10 numbers.

```
      ┌─────────┐
      │  Start  │
      └────┬────┘
           ▼
      ┌─────────┐
      │  i = 0  │
      └────┬────┘
           ▼
      ┌──────────┐
      │ Sum = 0  │
      └────┬─────┘
           ▼
      ┌────────────┐
      │ i = i + 1  │
      └────┬───────┘
           ▼
       Input  xi
           ▼
      ┌──────────────────┐
      │ sum = sum + xi   │
      └────┬─────────────┘
           ▼
       ◇ i = 10 ? ◇
           ▼
      ┌──────────────┐
      │ Av = sum / 10│
      └────┬─────────┘
           ▼
       Print Av
           ▼
      ┌─────────┐
      │   END   │
      └─────────┘
```
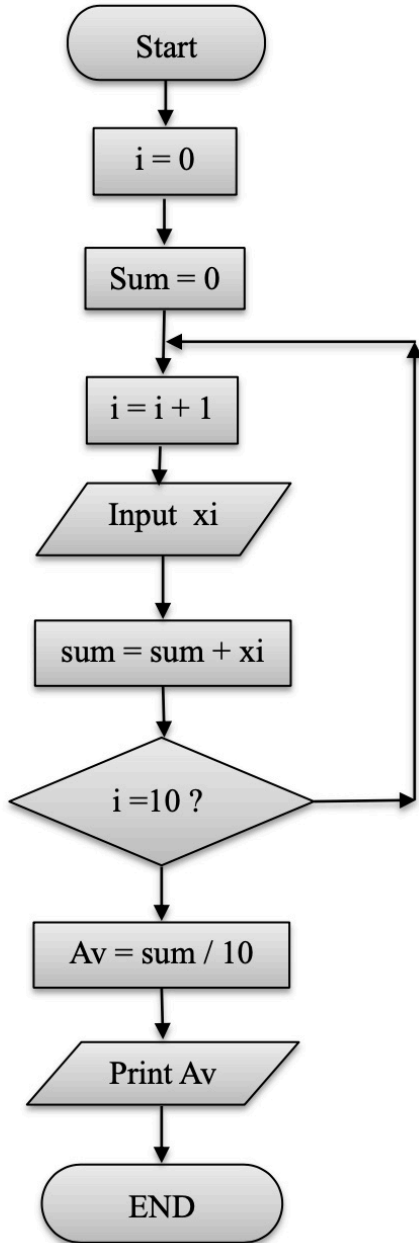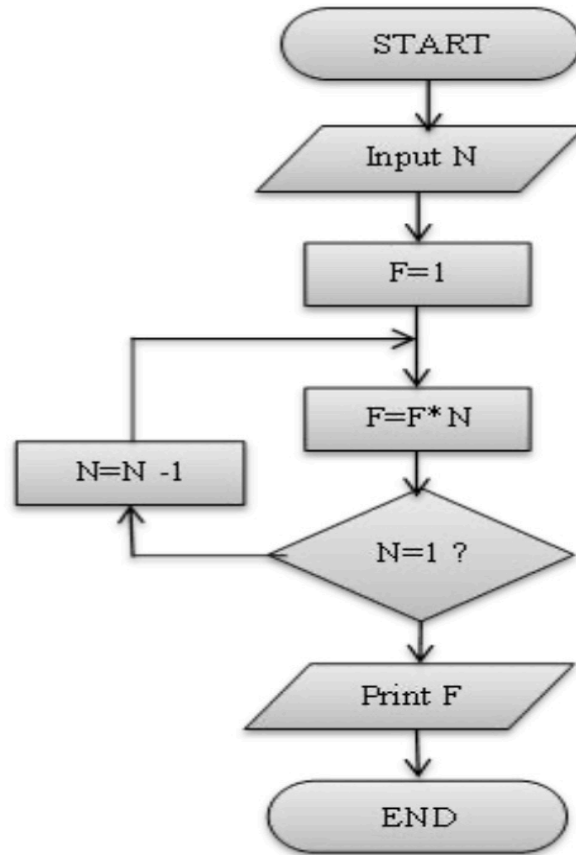
Ex: Draw a flowchart to read a number "x" then calculate y using the formula: (100 terms):

$$y = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} \dots \dots \dots \dots ..$$

```
      ┌─────────┐
      │  Start  │
      └────┬────┘
           ▼
       Input  x
           ▼
      ┌─────────┐
      │  y = 0  │
      └────┬────┘
           ▼
      ┌─────────┐
      │  k = 1  │
      └────┬────┘
           ▼
      ┌─────────┐
      │  i = 0  │
      │  j = 1  │
      └────┬────┘
           ▼
      ┌──────────┐
      │ i = i+1  │
      └────┬─────┘
           ▼
  ┌───────────────────────┐      ┌──────────┐
  │ y = y + ( k * x^j / j)│      │ j = j+2  │
  └────┬──────────────────┘      │ k = -1*k │
       ▼                         └──────────┘
   ◇ i = 100 ? ◇ ──────────────────►
       ▼
    Print y
       ▼
  ┌─────────┐
  │   END   │
  └─────────┘
```
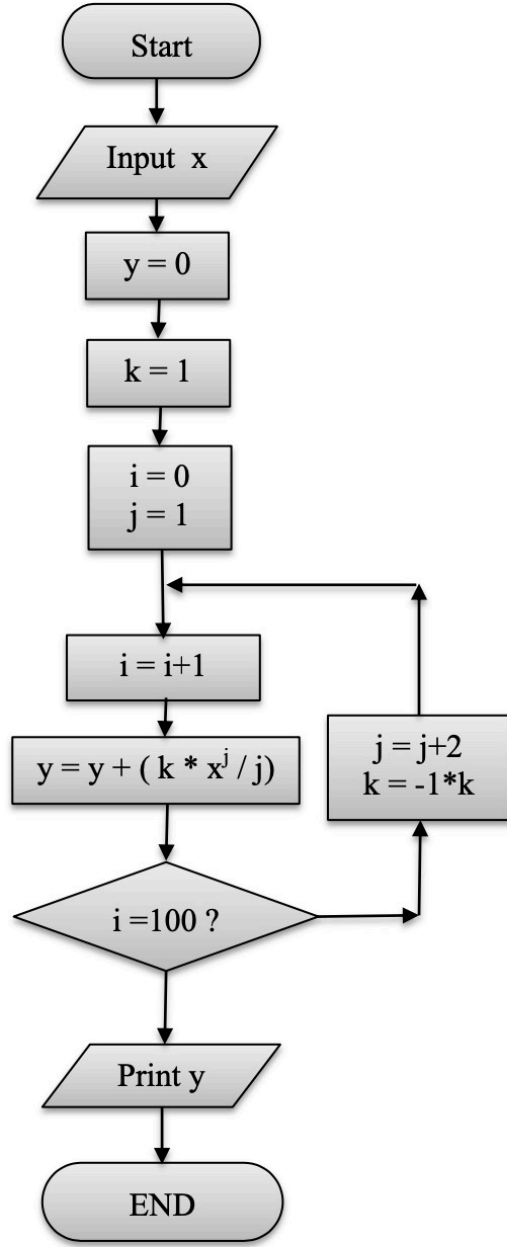
Ex: Draw a flowchart for computing the factorial of a positive integer N.

H.W. 1:

Draw a flowchart that reads a temperature in Fahrenheit degrees and convert it into Celsius degrees, using the formula

$$C^0 = \frac{9}{5}(F^0 - 32)$$

H.W. 2:

Draw a flowchart that finds the value of y from the following series

$$y = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} \dots \dots \dots \dots + \frac{x^{15}}{15!}$$