CHAPTER ONE

Algorithms and Flowcharts

Introduction

A program is a set of instruction gave to the computer to execute successive operations leads to solve specific problem. In general to solve any problem in computer we must follow these steps:

- 1. Analyze the problem.
- 2. Write an Algorithm.
- 3. Draw flowchart.
- 4. Convert the flowchart to program.
- 5. Run the program and test the solution.

1-1: Algorithms

It is a combination of phrases and events that can be arranged as steps to solve a specific problem. That can be done by understanding this problem whether it mathematic or logic before convert it to flow chart. As example when we borrow some books from the library, the remaining books number (N_R) is the subtraction of the borrowed books number (N_B) from the original number (N_O) . To write the algorithm for this simple problem we will follow these steps:

- 1. Input the number of books in the library (N_0) .
- 2. Input the number of borrowed books (N_B) .
- 3. Find the remaining books number (N_R), $N_R = N_O N_B$
- 4. Print N_R

1-2: Flowcharts

Flowcharts are graphs that represent the formal view used to solve any problem. Flowcharts help the programmer to write his program. Flowcharts consist of a shapes connected by a straight lines. The following table shows these shapes and their operations.

Shape	Operation
	Start or End
	Input / Output data Read or Input Print
	Processing / Storing Add(+) , Sub(-) , Mul(*) , Div(/) , Power(^), Store a value (Put)
$\uparrow \downarrow \longrightarrow$	Flow Lines

Connection	
Decision If statement Question (?) 	
Looping / Counters	
Subroutine	

We can summarize the use of algorithms and flowcharts as follow:

- 1. To show the mathematical logic used to solve problems.
- 2. To show how the data processing is done.
- 3. Helps the programmer to write his program.
- 4. Divides the big problem to smaller parts.
- 5. To avoid the errors that occurred during writing the program.
- 6. It is a middle step between problem difficulty and its conversion to suitable program.
- 7. Easy to convert it to any programming language.

In general, we can divide flowcharts to a four shapes (charts):

- **1. Simple sequence charts**
- 2. Branched charts.
- 3. Single loop charts.
- 4. Multi-loop charts.

1-2-1: Simple sequence charts

The events arrangement of this type is as straight sequence from the beginning of the program to the end (Event-1 to Event-n in figure below). This type of charts does not have any branches or loops.



Example-1:

Write an algorithm and draw a flow chart to read five numbers and find their sum and average. Print the results.



Example-2:

Write an algorithm and draw a flow chart to find the value of A, B, C from the following equations:

$A = X^2 + 2Y$, B = 2X-3A, $C = A^2-XB$

Where X and Y represents a circle area and circumference respectively. Input the radius (R) and print the value of A, B and C.



1-2-2: Branched charts

The need for the branching is to make decisions or comparison between two or more choices. Each choice will flow in different way (branch). Generally the branched charts may take one of the two forms below:



Example-3

Write an algorithm and draw a flow chart to find the value of the below function. Input X and print F(X) to each value of X.

$$F(X) = \begin{cases} X & : \text{ if } X \ge 0 \\ -X & : \text{ if } X < 0 \end{cases}$$



Example-4

Write an algorithm and draw a flow chart to evaluate W from the below equation. Input X and print the value of W for each value of X.

$$W = \begin{cases} X+1 & : X > 0 \\ Sin(X) + 5 & : X = 0 \\ 2 X-1 & : X < 0 \end{cases}$$



1-2-3: Single loop charts

These charts are used when we need to repeat an operation or group of operations to specific (or non specific) number of times. These types of charts are used to create the counters. Counters are used to repeat an operation or group of operations in specific number. Counters can be divided to two forms:

- General form.
- Conventional form.

1- General form

This type of counters can be represented according to the following form:

Where:

- I : Counter name (may take any symbol)
- S: Initial (Starting) value
- E: End (Final) value
- Δ : Step size (if not indicated, its value will be 1)



2. Conventional form.

The form of this type of counters will be as shown:



Example-5

Write an algorithm and draw a flow chart to find the area of (N) circles. Input the circles and print the result. Use the general form.



Example-6

Write an algorithm and draw a flow chart to evaluate Y from the bellow equations for seven entering values of X. If you know that a=-8, print the value of Y for each value of X. Use the conventional form.

$$\mathbf{Y} = \begin{cases} 3\mathbf{X}^2 - |\mathbf{X}| & : \mathbf{X} \ge \mathbf{0} \\ \mathbf{X} + \mathbf{a} & : \mathbf{X} < \mathbf{0} \end{cases}$$

Solution:





1-2-4: Multi-loops charts.

Its so called because it contains many loops. These loops are nested together without intersection. As shown the loop no.1 is called "inner loop" and loop no.2 the outer loop. The priority of execution will be to the internal loops then sequentially to the internal loops.



Example-7

Metal plate cutter machine used to cut plates its length is (5 meters). If you know that the length of each plate is more than (30 meters), write an algorithm and draw a flowchart to clarify this operation.



1-3: Solved Problems

Problem-1

Discuss the flowing flow chart and show its purpose and final results.

Answer

This flowchart prints the odd numbers from 1 to 79 and its sum.



Iroblem-2

Discuss the flowing flow chart and show its purpose and final results.

Answer

This flowchart prints the sum of numbers from 1 to 12 in steps of 0.5.



Iroblem-3

Discuss the flowing flowcharts (A and B) and show there purposes and final results.



Answer-A-

This flowchart finds and prints the even numbers from 0 to 90 and prints the sum.

Answer-B-

This flowchart finds and prints the sum and the number of positive numbers for ten input values of X.

Troblem-4

Draw a flowchart to find and print the value of F from the following equations for ten known values of X, Y, and M.

$$F = \begin{cases} XY+5 & : M = 1 \\ X^2-Y^2 & : M = 2 \\ \frac{X+Y}{X^2} & : Elsewhere \end{cases}$$

Answer



1-4: Problems

C1: Write an algorithm and draw a flowchart to calculate A1, A2, A3 from the following equation:

$$A1 = X2+Y2$$
, $A2 = A1-3XY$, $A3 = |A1||A2|$

Where X and Y are evaluated from the equations:

X, Y = $\sqrt[3]{z} \mp 4\sqrt{z}$

٢

Print A1, A2, A3 for each input value of z.

Q2: Write an algorithm and draw a flowchart to calculate W from the following equations:

W =
$$\begin{cases} X+Y & : X > 0, Y < 0\\ X^{2}Y^{3} + 5X & : X = 0, Y > 0\\ \frac{2X}{3Y} + 4X & : X < 0, Y = 0 \end{cases}$$

Print W for each input value of X and Y.

- **(23**: Draw a flowchart to enter a number represents a Celsius degree (C) then convert it to Fahrenheit degree (F) according to the relation: F = (9C / 5) + 32. Then print the grade of this degree by using the following relations:
 - "Cold" when $F \le 41$. "Nice" when $41 \le F \le 77$. "Hot" when $F \ge 77$.
- **Q**4: A list contains three degrees for 100 students, draw a flowchart to enter these degrees and print the grade according to table below. Use the conventional form.

- Q5: A list contains N degrees in computer course, draw a flowchart to calculate the percentage rate for the degrees limited between 60% and 70%. Use the conventional form.
- **Q**6: Write an algorithm and draw a flowchart to enter a 40 numbers then find and print number and sum for the numbers greater than 0 and less than 25 and numbers greater than 25. Use the general form.

Degree	Grade
0 - 49	Weak
50 - 59	Acceptable
60 - 69	Fluent
70 - 79	Good
80 - 89	Very Good
90 - 100	Excellent

- *Q7:* Write an algorithm and draw a flowchart to enter a 50 numbers then find and print number and sum for the positive and negative numbers. Use the conventional form.
- *C8:* Write an algorithm and draw a flowchart to find and print number and sum for the even and odd numbers for M entered numbers. Use the conventional form.
- **(29:** By using the conventional form, draw a flowchart to find and print the power on the resistor R_4 .



C10: Enter two numbers represents two readings for an electrical power consumption in the first and end of a specific month. Draw a flowchart to evaluate the consumption wage for 50 consumers according to the following table:

Consumption unit	Cost (in Dinar)
1 ←300	8
301 ←360	10
361 ←900	20
≥ 901	30