

Microcontroller Project Development

Thanh Vo-Duy

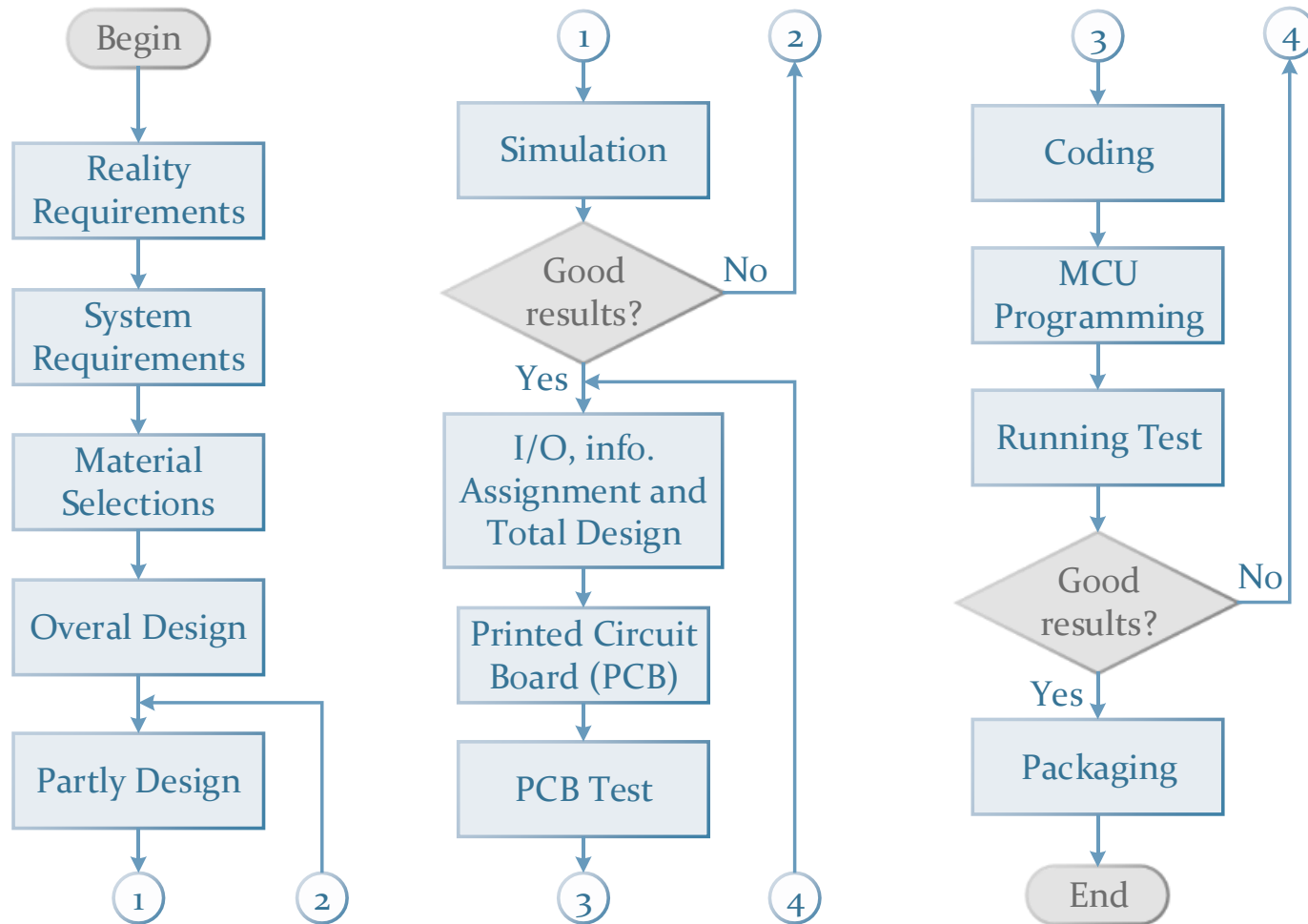
Department of Industrial Automation

thanh.voduy@hust.edu.vn

Content

- Project Development General Procedure
- Hardware and Software Requirements
- Program Development Tools
 - Flow Charts
 - Structure Charts
 - Pseudocode
- Exercises

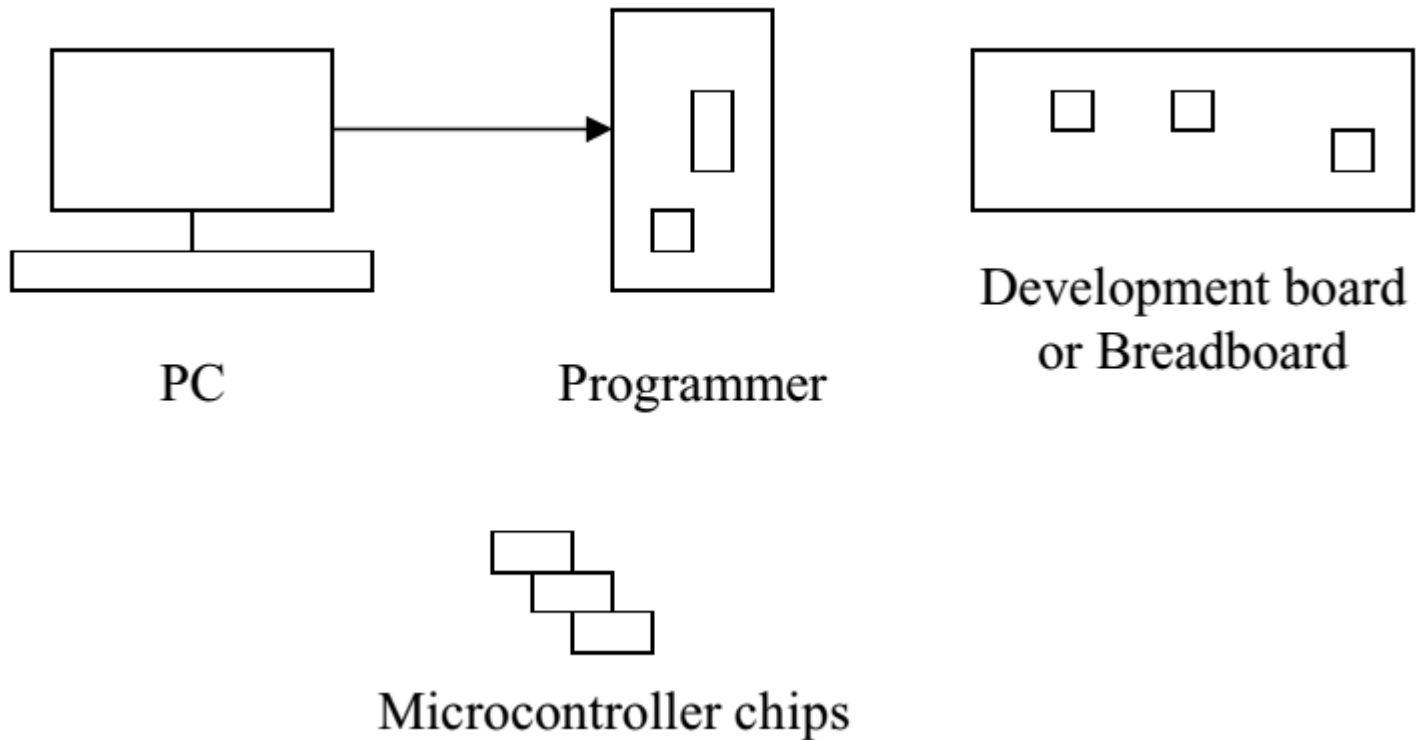
Project Development General Procedure



Hardware and Software Requirements

- Hardware requirements depend on complexity
- General requirements of all project
 - Microcontroller programmer
 - Development board or breadboard
 - Microcontroller chip
 - PC
 - Multi-meter or oscilloscope
 - Signal generator

Hardware and Software Requirements



Hardware and Software Requirements

- Minimum requirements for Software
 - Program development software
 - Microcontroller assembler (or compiler – high level)
 - Microcontroller device programmer software
- Additional software
 - Simulators
 - Debugger
 - Emulator (In-circuit Emulator)

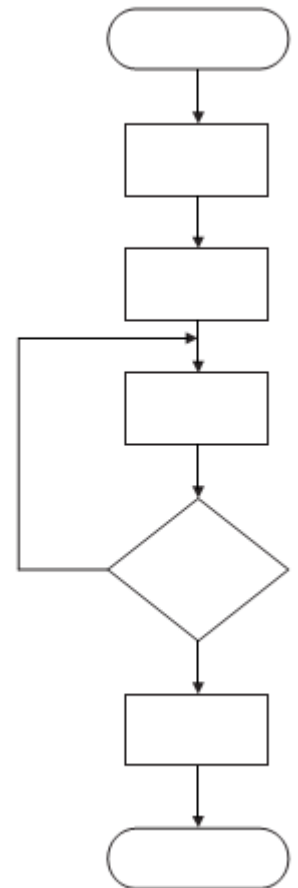
Program Development Tools

- Basic Tools (methods)
 - Modular Programming
 - Structured Programming – Software Tasks
- Popular Tools:
 - Flow Charts
 - Structure Charts
 - Unified Modeling Language
 - Nassi-Schneidermann/Ferstl/Hamilton-Zeldin diagrams
 - Pseudocode

Program Development Tools

Flow Charts

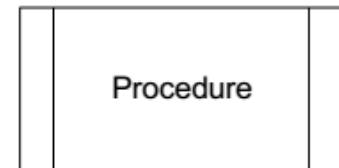
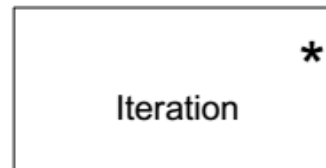
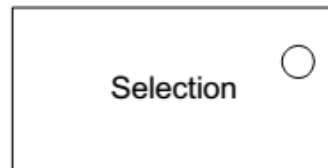
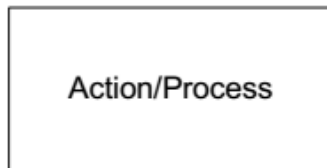
- Flow Charts used shapes to present program
 - Start/End
 - Process
 - Decision
 - Data...
- Disadvantages
 - Used only for small applications
 - Modification and drawing are time-consuming
 - Unstructured code is difficult to maintain



Program Development Tools

Structure Charts

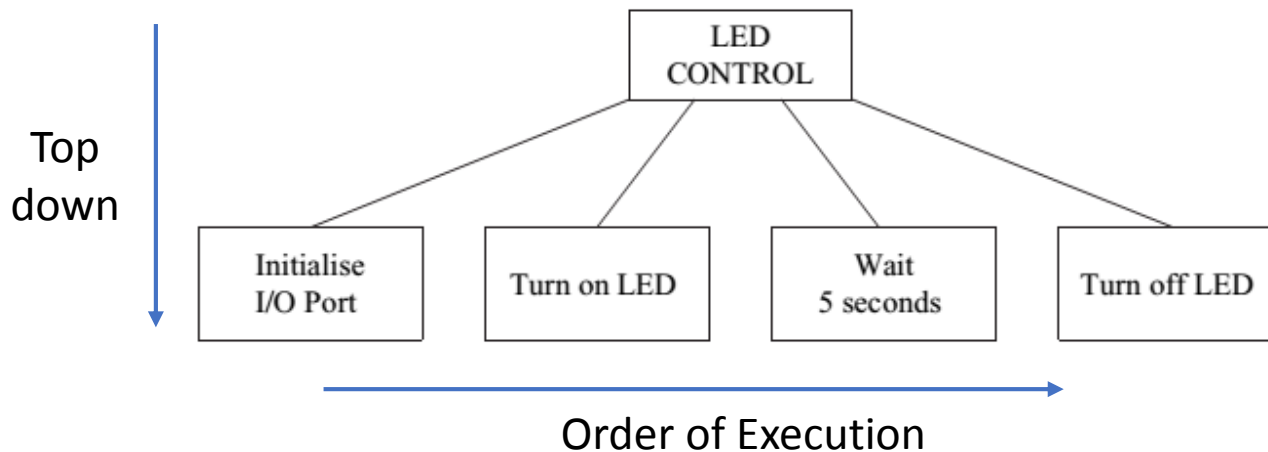
- Known as Jackson structured programming tools
- Initially developed in 1970s by Michael Jackson
- Similar to flow charts but easier to draw and modify
- Well-structured code, easy to understand and maintain
- 3 basic operations: sequence, selection, iteration



Program Development Tools

Structure Charts

- Sequence
 - Rectangle drawn next to each other
 - Operation is s from left to right

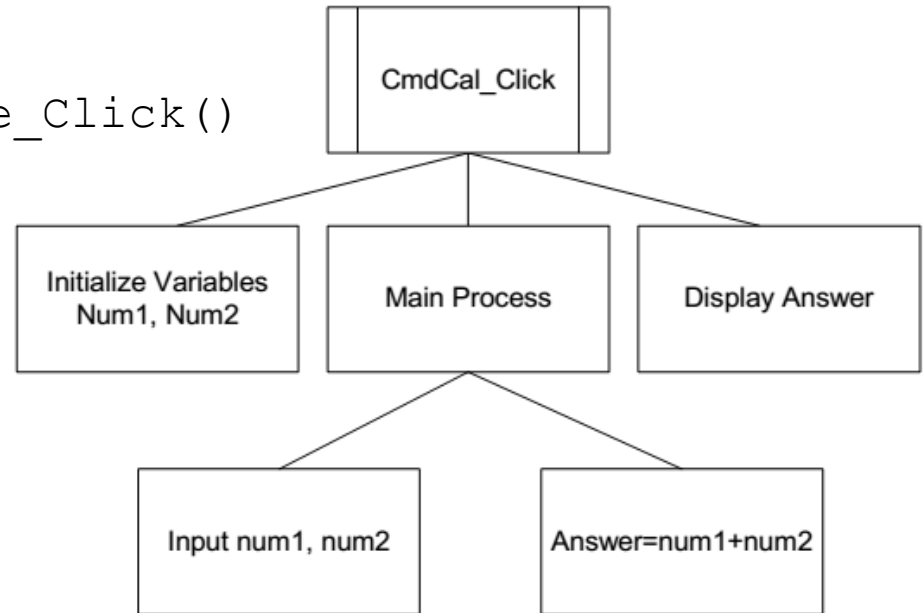


Program Development Tools

Structure Charts

- Example of Sequence

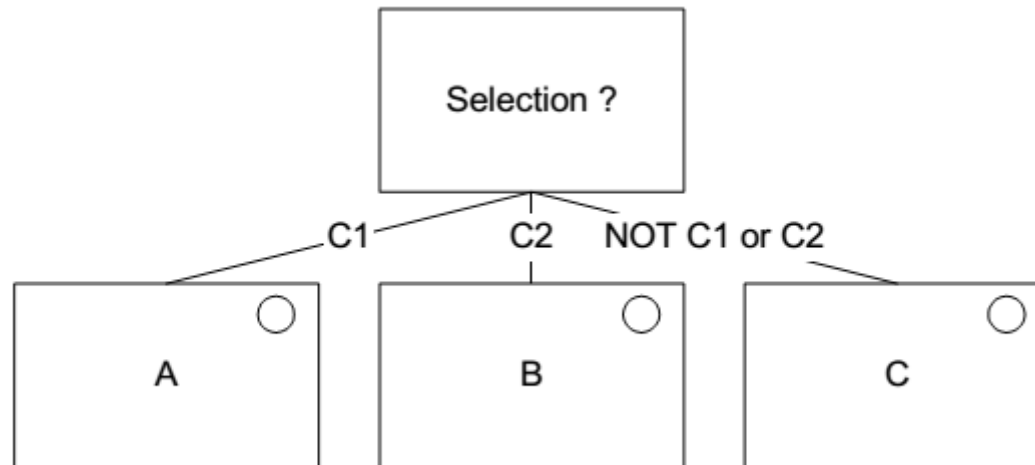
```
Private Sub cmdCalculate_Click()  
Dim num1 As Byte  
Dim num2 As Byte  
Dim answer As Byte  
num1 = Val(txtNum1)  
num2 = Val(txtNum2)  
answer = num1 + num2  
lblAnswer = CStr(answer)  
End Sub
```



Program Development Tools

Structure Charts

- Selection
 - Small circle at top right-hand side of rectangle

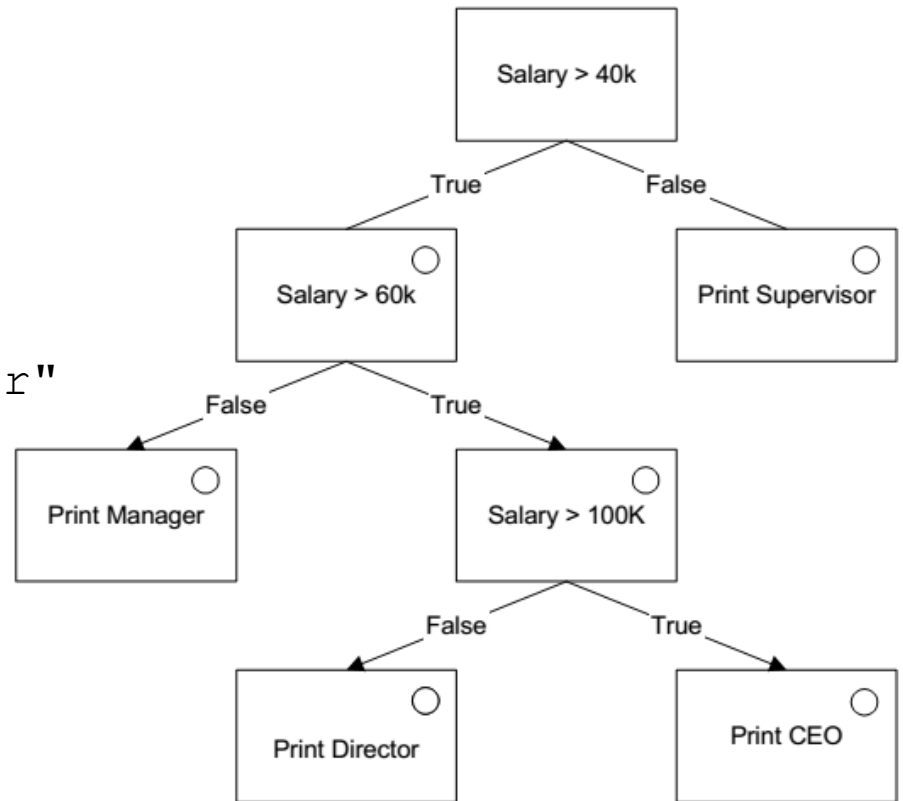


Program Development Tools

Structure Charts

- Example of Selection (if ... then statement)

```
if Sal > 40 then
  if Sal > 60 then
    if Sal > 100 then
      print "CEO";
    else
      print "Director"
  else
    print "Manager"
else
  print "Supervisor"
```

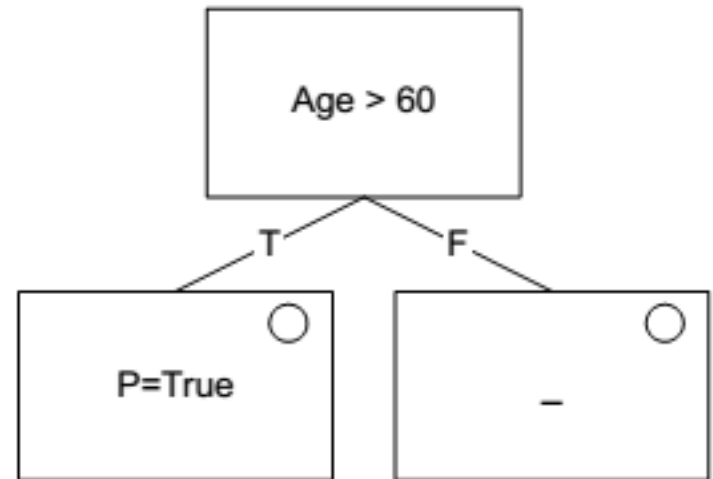


Program Development Tools

Structure Charts

- Example of Selection (if ... then statement)

```
if Age > 60 then  
    P = True  
endif
```

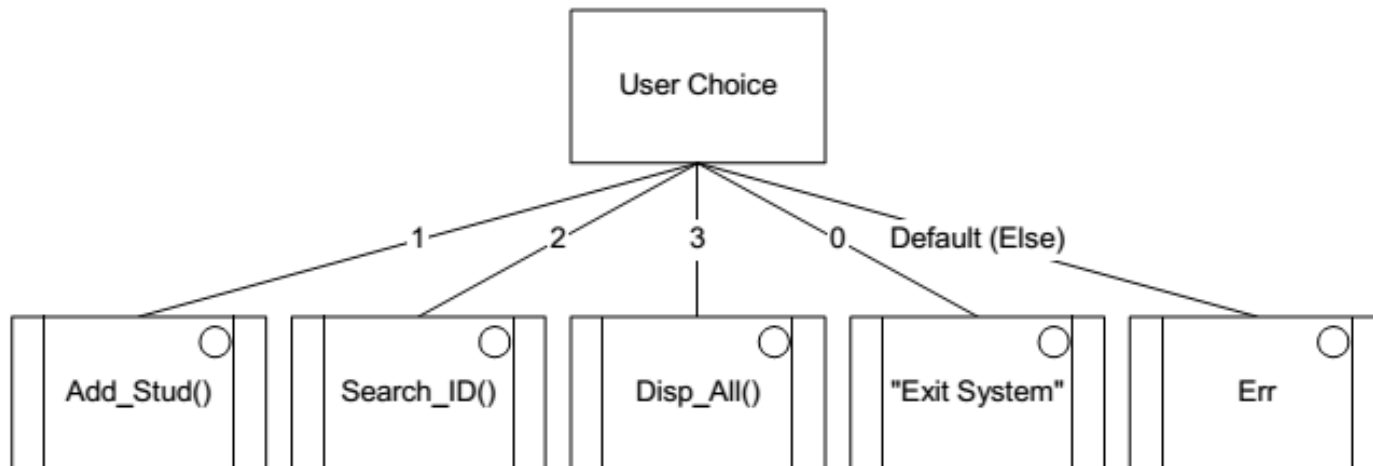


Program Development Tools

Structure Charts

- Example of Sequence (switch ... case statement)

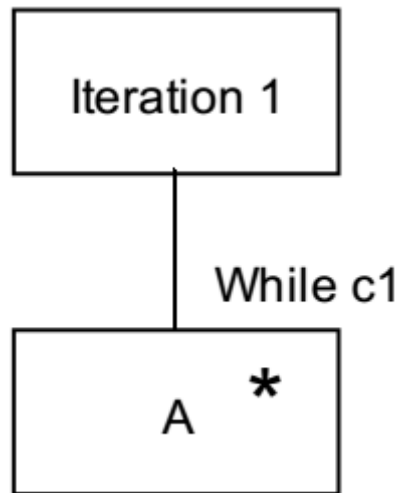
```
switch(ch)
{
    case 1: Add_Stud();   break;
    case 2: Search_ID();  break;
    case 3: Disp_All();   break;
    case 0: cout<<"Exiting Student Management System...\n\n";exit(1);
    default: cout<<"Invalid choice made....try again!";break;
}
```



Program Development Tools

Structure Charts

- Iteration
 - Small asterisk sign at the top right-hand of a rectangle.

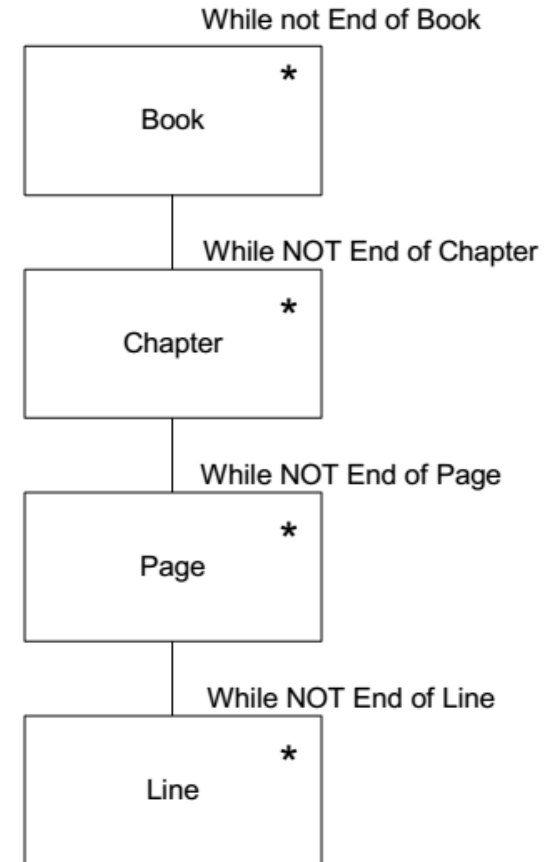


Program Development Tools

Structure Charts

- Example of Iteration

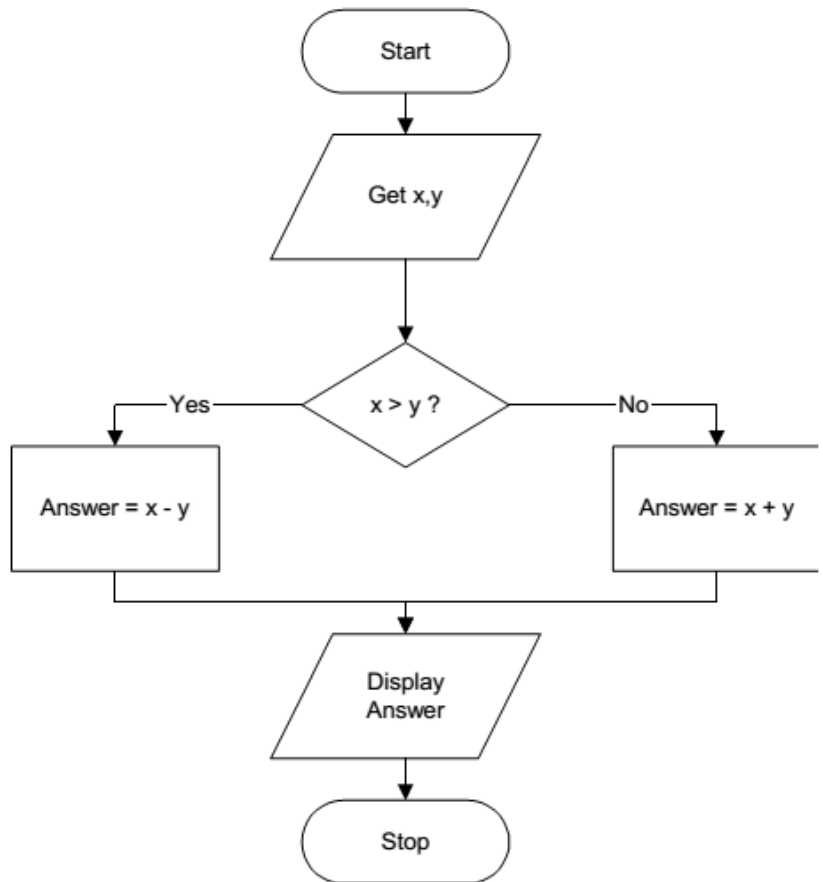
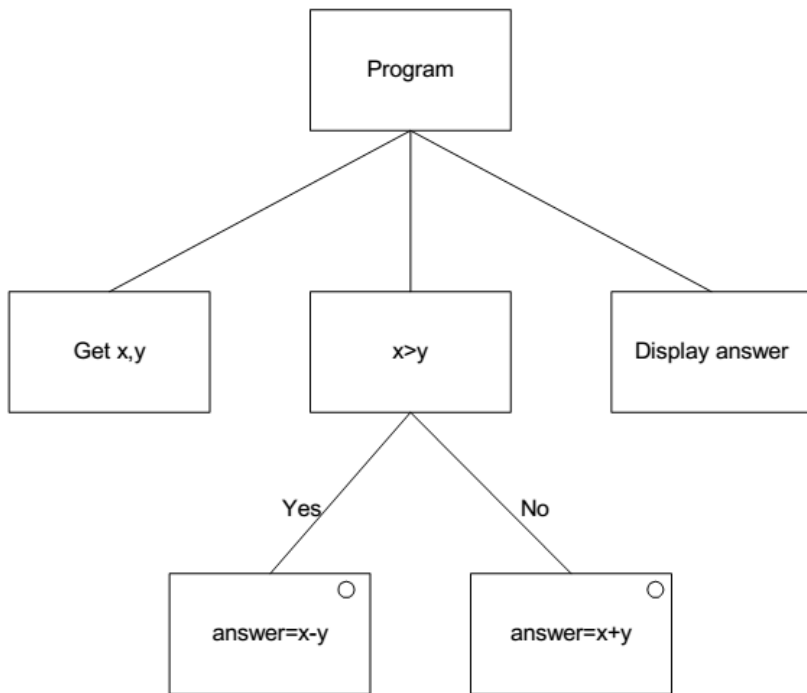
```
While NOT End of Book
  While NOT End of Chapter
    While NOT End of Page
      While NOT End of Line
        . . . .
      End While
    End While
  End While
End While
```



Program Development Tools

Structure Charts

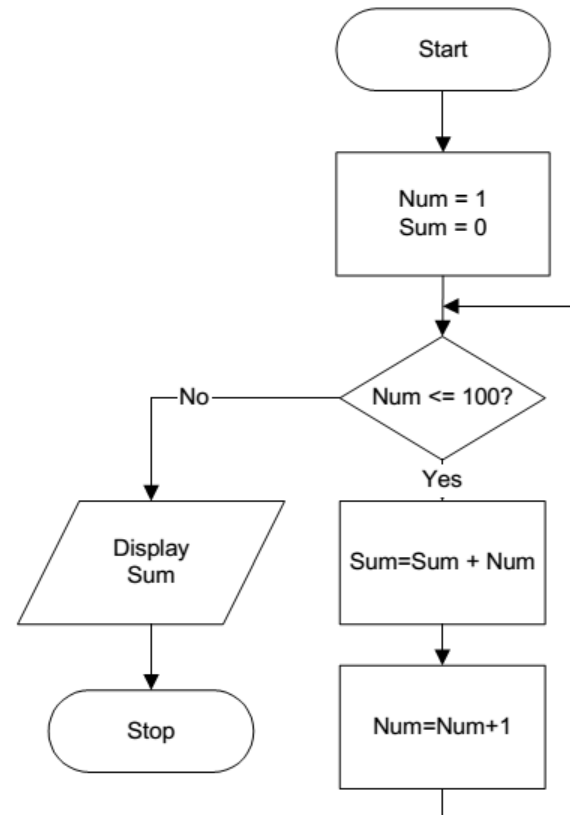
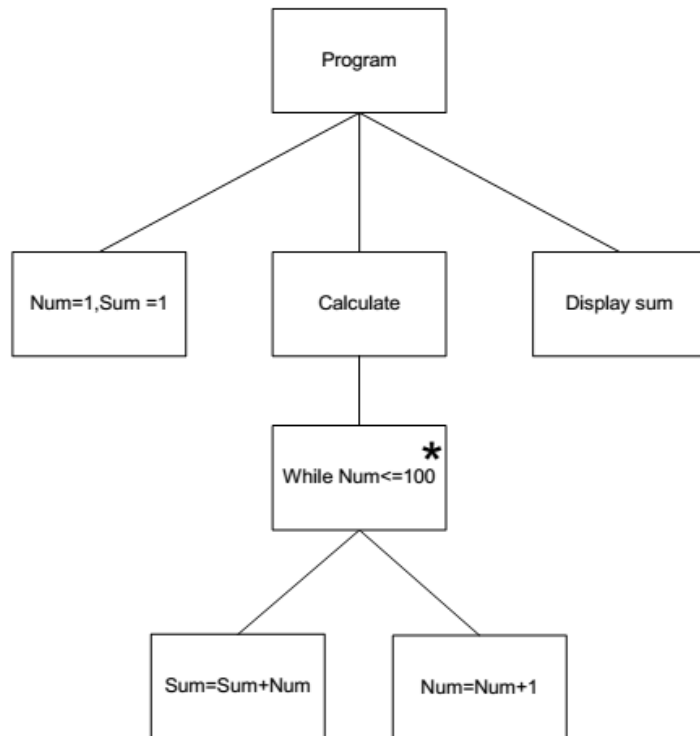
- Structure Charts and Flow Charts



Program Development Tools

Structure Charts

- Structure Charts and Flow Charts



Program Development Tools

Pseudocode

- Disadvantage of graphical design method
 - Time consume
 - Not easy to modify
- Pseudocode: a kind of structure language (Eng.)
 - Describe operation of algorithm
 - Concentrate on development of algorithm

Program Development Tools

Pseudocode

- Some features
 - No fixed rule or standard of developing pseudocode
 - Developer may have his own style
 - Pseudocode uses English sentences or keywords
 - Cannot be compiled
- Still have guideline to develop pseudocode
 - Sequencing
 - Selection
 - Iteration

Program Development Tools

Pseudocode

- **BEGIN – END**

- Declare the beginning and end of program/module
- E.g. Keyword “:**MAIN**” for main program

:MAIN

BEGIN

...

...

END

Program Development Tools

Pseudocode

- Sequencing

- Input: READ, GET, OBTAIN
- Output: SEND, PRINT, DISPLAY, SHOW
- Initialize: SET, CLEAR, INITIALIZE
- Compute: ADD, CALCULATE, DETERMINE
- Actions: TURN ON, TURN OFF

- Example

:MAIN

BEGIN

Read three numbers

Calculate their sum

Display the result

END

Program Development Tools

Pseudocode

- **IF – THEN – ELSE – ENDIF**

IF condition **THEN**

statement

statement

ELSE

statement

statement

ENDIF

- Example

IF temperature>100 **THEN**

Turn off heater

Start the engine

ELSE

Turn on heater

ENDIF

Program Development Tools

Pseudocode

- **REPEAT – UNTIL**

REPEAT

Statement

Statement

Statement

UNTIL condition

- **Example**

Set cnt=0

REPEAT

Turn on LED

Wait1s

Turn off LED

Wait1s

Increment cnt

UNTIL cnt=5

Program Development Tools

Pseudocode

- **DO – WHILE**
 DO
 statement
 statement
 statement
 WHILE condition

- **Example**
 Set cnt=0
 DO
 Turn on LED
 Wait1s
 Turn off LED
 Wait1s
 Increment cnt
 WHILE cnt<5

Program Development Tools

Pseudocode

- **WHILE – WEND**

WHILE condition
statement
statement
statement

WEND

- Example

<pre>I=0 WHILE I>0 Turn on LED Wait3s Turn off LED WEND</pre>	<pre>I=0 WHILE I<10 Turn on motor Wait 2 seconds Turn off motor Increment I WEND</pre>
--	---

Program Development Tools

Pseudocode

- **CASE – CASE ELSE – END CASE**

CASE expression **OF**

condition1:

statement

statement

condition2:

statement

statement

condition3:

statement

statement

...

...

CASE ELSE

statement

statement

END CASE

Program Development Tools

Pseudocode

- **CASE – CASE ELSE – END CASE** - Example

CASE grade **OF**

A: points=10

B: points=8

C: points=6

D: points=4

CASE ELSE points=0

END CASE

Program Development Tools

Pseudocode

- Invoking Modules

- Keyword: “**CALL**”
- Input/Output must be declared

- Example:

Write the pseudocode for an application where three numbers are read from the keyboard into a main program, their sum calculated using a module called SUM, and the result displayed by the main program.

Program Development Tools

Pseudocode

- Solution

:MAIN

BEGIN

Read 3 numbers a, b, c from the keyboard

CALL SUM (a, b, c)

Display result

END

:SUM (I: a, b, c O: sum of numbers)

BEGIN

Calculate the sum of a, b, c

Return sum of numbers

END

Exercises

1. What are the three major components of a flow chart? Explain the function of each component with an example.
2. Draw a flow chart for a simple sort algorithm.
3. Draw a flow chart for a binary search algorithm.
4. What are the differences between a flow chart and a structure chart?
5. What are the three major components of a structure chart? Explain the function of each component with an example.
6. Draw a flow chart to show how a quadratic equation can be solved.

Exercises

7. What are the advantages of pseudocode?
8. What are the basic components of pseudocode?
9. Write pseudocode to read the base and the height of a triangle from the keyboard, call a module to calculate the area of the triangle and display the area in the main program.
10. Explain how iteration can be done in pseudocode. Give an example.
11. Give an example of pseudocode to show how multi-way selection can be done using the CASE construct. Write the equivalent IF–ELSE–ENDIF construct