G.C.E. O/L Grade 11 ICT · Lesson 1

1.8 Nested Control Structures

Syllabus 10.8. A structure placed **inside** another structure is **nested** – like a small box inside a bigger box. We can put a selection inside a selection, a loop inside a loop, a selection inside a loop, or a loop inside a selection. Real programs use nesting all the time.

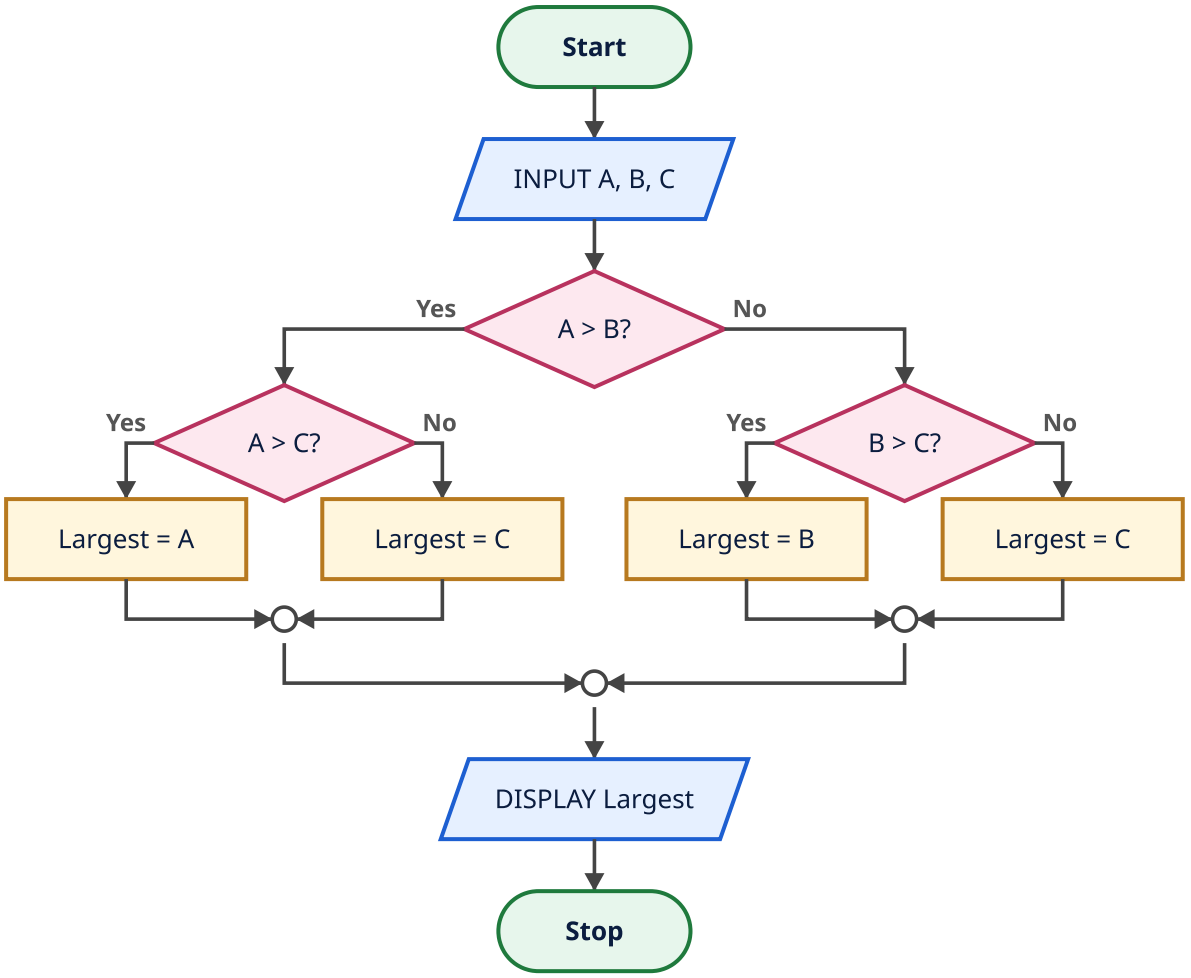
1. Selection inside selection

To find the largest of three numbers A, B and C: first ask “Is A > B?”. Then, **inside each answer**, ask a second question with C. The inner IF runs only when the outer IF reaches it.

Pseudocode

```
BEGIN
  INPUT A, B, C
  IF A > B THEN
    IF A > C THEN
      Largest = A
    ELSE
      Largest = C
    ENDIF
  ELSE
    IF B > C THEN
      Largest = B
    ELSE
      Largest = C
    ENDIF
  ENDIF
  DISPLAY Largest
END
```

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Flowchart – Selection inside selection: largest of three

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Selection inside selection: largest of three

Pascal

```
program Largest3;
var
  a, b, c, largest: integer;
begin
  write('Enter A: ');
  readln(a);
  write('Enter B: ');
  readln(b);
  write('Enter C: ');
  readln(c);
  if a > b then
  begin
    if a > c then
      largest := a
    else
      largest := c;
  end
  else
  begin
    if b > c then
      largest := b
    else
      largest := c;
  end;
  writeln('Largest = ', largest);
end.
```

Python

```
a = int(input("Enter A: "))
b = int(input("Enter B: "))
c = int(input("Enter C: "))
if a > b:
    if a > c:
        largest = a
    else:
        largest = c
else:
    if b > c:
        largest = b
    else:
        largest = c
print("Largest =", largest)
```

Sample run 1

```
Enter A: 12
Enter B: 45
Enter C: 30
Largest = 45
```

Sample run 2

```
Enter A: 50
Enter B: 20
```

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```
Enter C: 35
Largest = 50
```

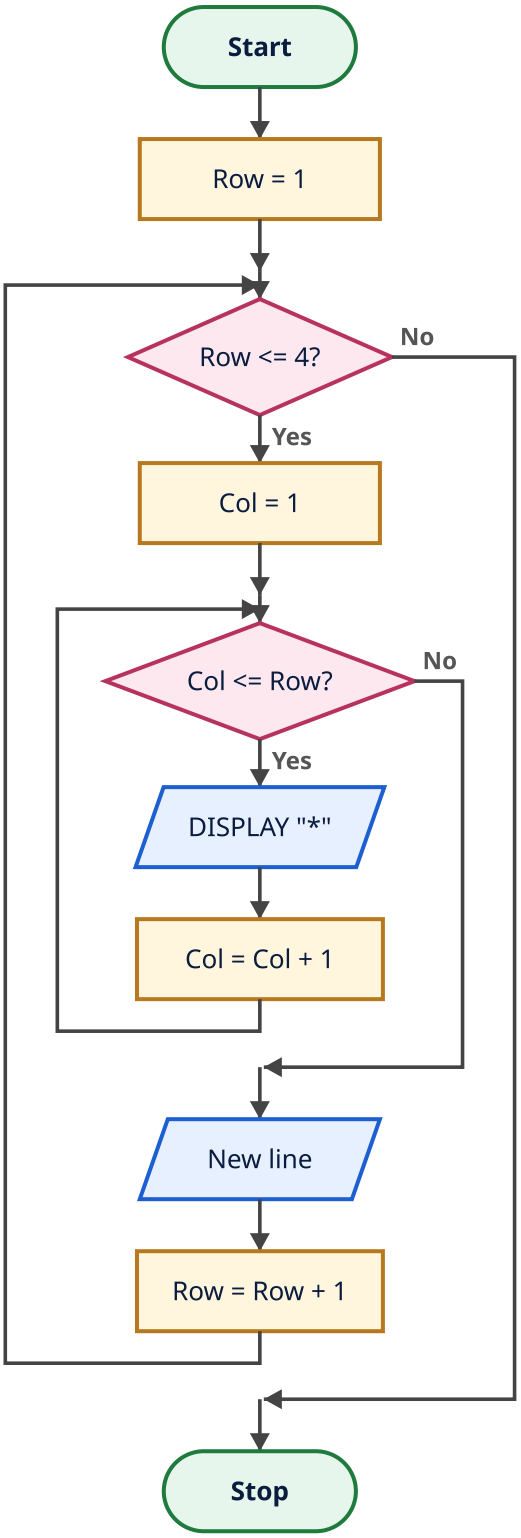
2. Iteration inside iteration

An **inner loop** runs **completely** for **every single run** of the outer loop. In the star triangle, the outer loop chooses the row; the inner loop prints that many stars.

Pseudocode

```
BEGIN
  FOR Row = 1 TO 4
    FOR Col = 1 TO Row
      DISPLAY "*" (same line)
    ENDFOR
    Move to a new line
  ENDFOR
END
```

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Flowchart – Iteration inside iteration: star triangle

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Iteration inside iteration: star triangle

Pascal

```
program Stars;
var
  row, col: integer;
begin
  for row := 1 to 4 do
  begin
    for col := 1 to row do
      write('*');
    writeln;
  end;
end.
```

Python

```
for row in range(1, 5):
    for col in range(1, row + 1):
        print("*", end="")
    print()
```

Sample run

```
*
**
***
****
```

Row	Inner loop runs (times)	Printed
1	1	*
2	2	**
3	3	***
4	4	****

> 💡 Total stars = 1 + 2 + 3 + 4 = 10. If the outer loop runs 4 times and the inner loop always ran 3 times, the inner body would run 4 × 3 = 12 times.

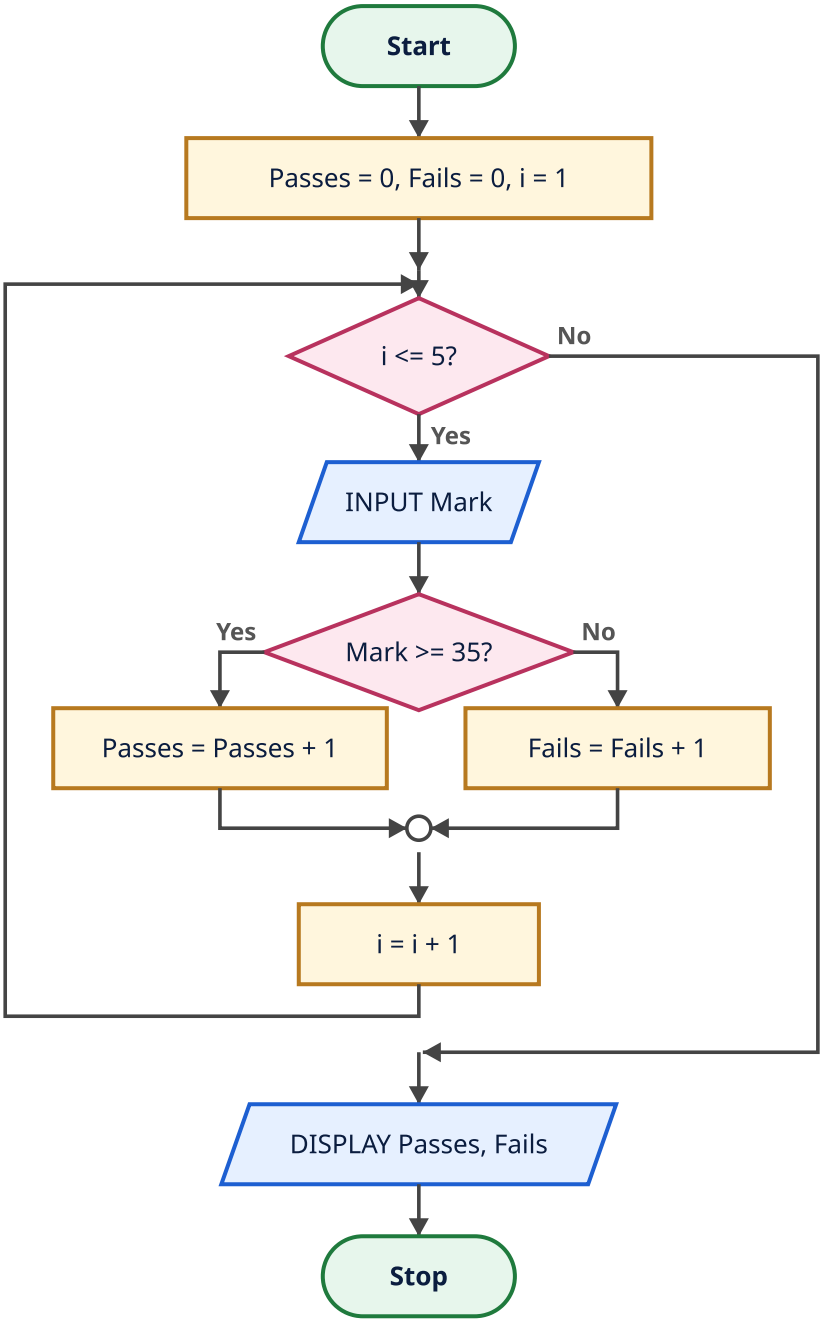
3. Selection inside iteration

A loop reads 5 marks. **Inside** the loop, an IF decides whether each mark is a pass (≥ 35) or a fail, and counts them.

Pseudocode

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```
BEGIN
  Passes = 0
  Fails = 0
  FOR i = 1 TO 5
    INPUT Mark
    IF Mark >= 35 THEN
      Passes = Passes + 1
    ELSE
      Fails = Fails + 1
    ENDIF
  ENDFOR
  DISPLAY Passes, Fails
END
```



Flowchart – Selection inside iteration: count passes and fails

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Selection inside iteration: count passes and fails

Pascal

```
program PassCount;
var
  i, mark, passes, fails: integer;
begin
  passes := 0;
  fails := 0;
  for i := 1 to 5 do
  begin
    write('Enter mark ', i, ': ');
    readln(mark);
    if mark >= 35 then
      passes := passes + 1
    else
      fails := fails + 1;
  end;
  writeln('Pass = ', passes);
  writeln('Fail = ', fails);
end.
```

Python

```
passes = 0
fails = 0
for i in range(1, 6):
    mark = int(input(f"Enter mark {i}: "))
    if mark >= 35:
        passes = passes + 1
    else:
        fails = fails + 1
print("Pass =", passes)
print("Fail =", fails)
```

Sample run

```
Enter mark 1: 45
Enter mark 2: 30
Enter mark 3: 78
Enter mark 4: 22
Enter mark 5: 60
Pass = 3
Fail = 2
```

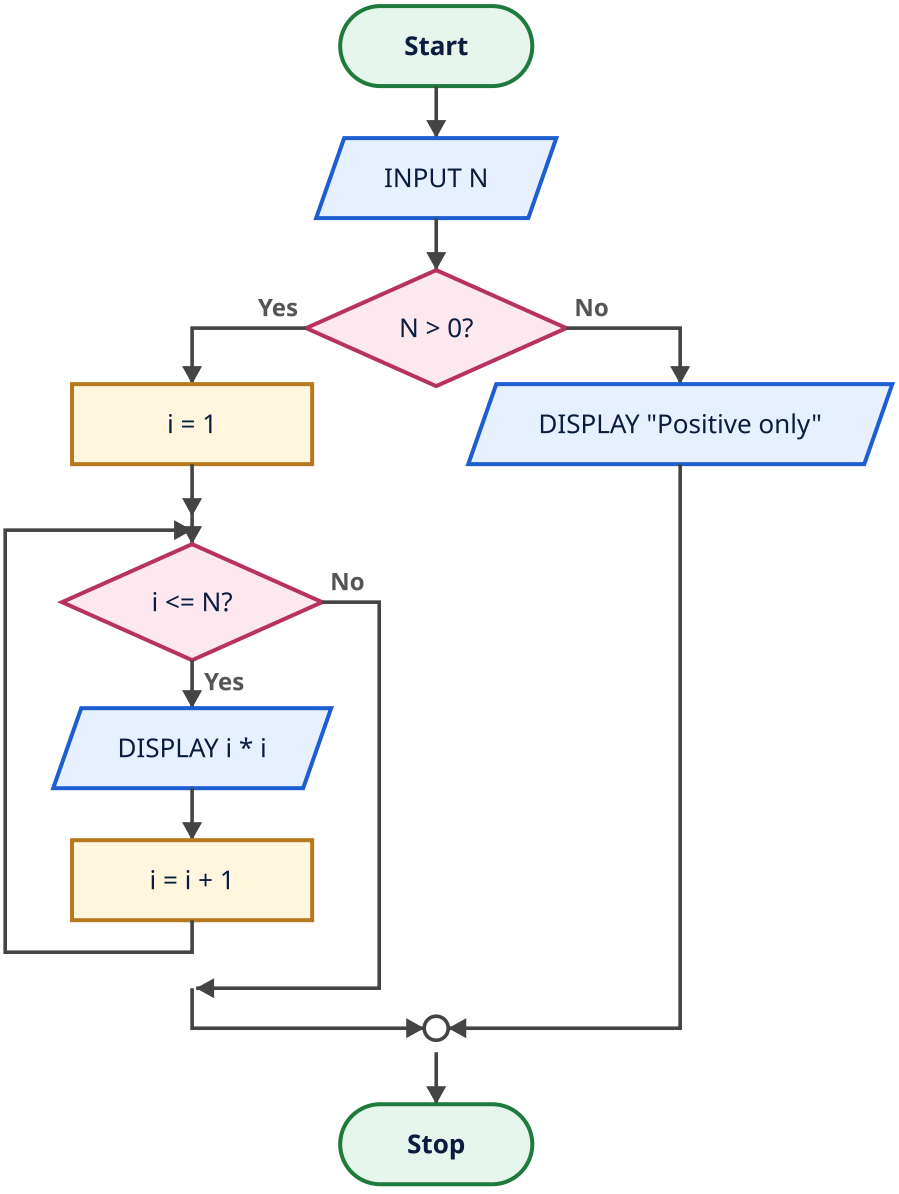
4. Iteration inside selection

First check that the input is positive. **Only if it is**, run a loop that displays the squares 1^2, 2^2, ...

Pseudocode

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```
BEGIN
  INPUT N
  IF N > 0 THEN
    FOR i = 1 TO N
      DISPLAY i * i
    ENDFOR
  ELSE
    DISPLAY "Please enter a positive number"
  ENDIF
END
```



Flowchart – Iteration inside selection: squares only for a positive number

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Iteration inside selection: squares only for a positive number

Pascal

```
program Squares;
var
  n, i: integer;
begin
  write('How many squares? ');
  readln(n);
  if n > 0 then
  begin
    for i := 1 to n do
      writeln('Square of ', i, ' = ', i * i);
  end
  else
    writeln('Please enter a positive number');
end.
```

Python

```
n = int(input("How many squares? "))
if n > 0:
    for i in range(1, n + 1):
        print("Square of", i, "=", i * i)
else:
    print("Please enter a positive number")
```

Sample run 1

```
How many squares? 4
Square of 1 = 1
Square of 2 = 4
Square of 3 = 9
Square of 4 = 16
```

Sample run 2

```
How many squares? -2
Please enter a positive number
```

5. Tips for nested code

- **Indent** each inner level a little more, so you can see which statement belongs where.
- Close the **inner** structure before the outer one (ENDIF before ENDFOR).
- In Pascal, use **begin … end** when a part has more than one statement.
- Use different counter names for nested loops (Row and Col, i and j).

Key Words

Nesting – Placing one control structure inside another.

Nested IF – An IF inside another IF.

Nested loop – A loop inside another loop.

Outer loop – The loop that contains another loop.

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Inner loop – The loop inside; it runs fully for each outer run.

Indentation – Spaces that show which level a statement belongs to.

begin … end – Pascal words that group several statements into one block.

Largest – The biggest value in a group.

Pass count – A counter that adds 1 for every pass.

Square – A number multiplied by itself, e.g. 4 × 4 = 16.

Positive number – A number greater than 0.

Level – How deep a structure is inside others.

Sample Q&A

1. What is a nested structure?

> **Answer:** A control structure placed inside another one.

2. For A = 12, B = 45, C = 30, what does the largest-of-three program display?

> **Answer:** Largest = 45.

3. If the outer loop runs 3 times and the inner loop runs 4 times each time, how many times does the inner body run?

> **Answer:** 12 times.

4. Marks 45, 30, 78, 22, 60 – how many passes and fails?

> **Answer:** Pass = 3, Fail = 2.

5. What does the squares program show for −2?

> **Answer:** Please enter a positive number.

6. Why do we indent nested code?

> **Answer:** To see clearly which statements belong to which structure.

MCQ

1. A loop placed inside another loop is a…

A. constant
B. sentinel
C. nested loop
D. case

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2. For A = 50, B = 20, C = 35, the largest is…

A. 50
B. 35
C. 105
D. 20

3. In the largest-of-three flowchart, the first question is…

A. A > C?
B. C > 0?
C. B > C?
D. A > B?

4. Outer loop runs 4 times, inner loop 3 times each. Inner body runs…

A. 3 times
B. 12 times
C. 4 times
D. 7 times

5. The last line of the star triangle (Row = 4) is…

A. *
B. ****
C. **
D. ***

6. Total stars in the 4-row triangle…

A. 10
B. 4
C. 16
D. 8

7. In the star program, the inner loop runs while…

A. Col = 0
B. Row > Col + 5
C. Col <= Row
D. Row <= 4 only

8. Marks 45, 30, 78, 22, 60 give Pass = …

A. 2
B. 4
C. 5
D. 3

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9. Counting passes inside a loop is an example of…

A. selection inside iteration
B. iteration inside selection
C. a nested array
D. sequence only

10. The squares program checks the number first, then loops. This is…

A. selection inside iteration
B. a case statement
C. a loop inside a loop
D. iteration inside selection

11. For input 4, the last line of the squares program is…

A. Square of 4 = 8
B. Square of 4 = 16
C. Square of 3 = 9
D. Square of 16 = 4

12. Which should be closed first?

A. the outer structure
B. the program
C. the inner structure
D. any one

13. In Pascal, several statements inside an IF must be grouped with…

A. [ ]
B. begin … end
C. { }
D. ( )

14. Good names for two nested loop counters are…

A. both Total
B. x and x
C. Row and Col
D. both i

15. Nesting means…

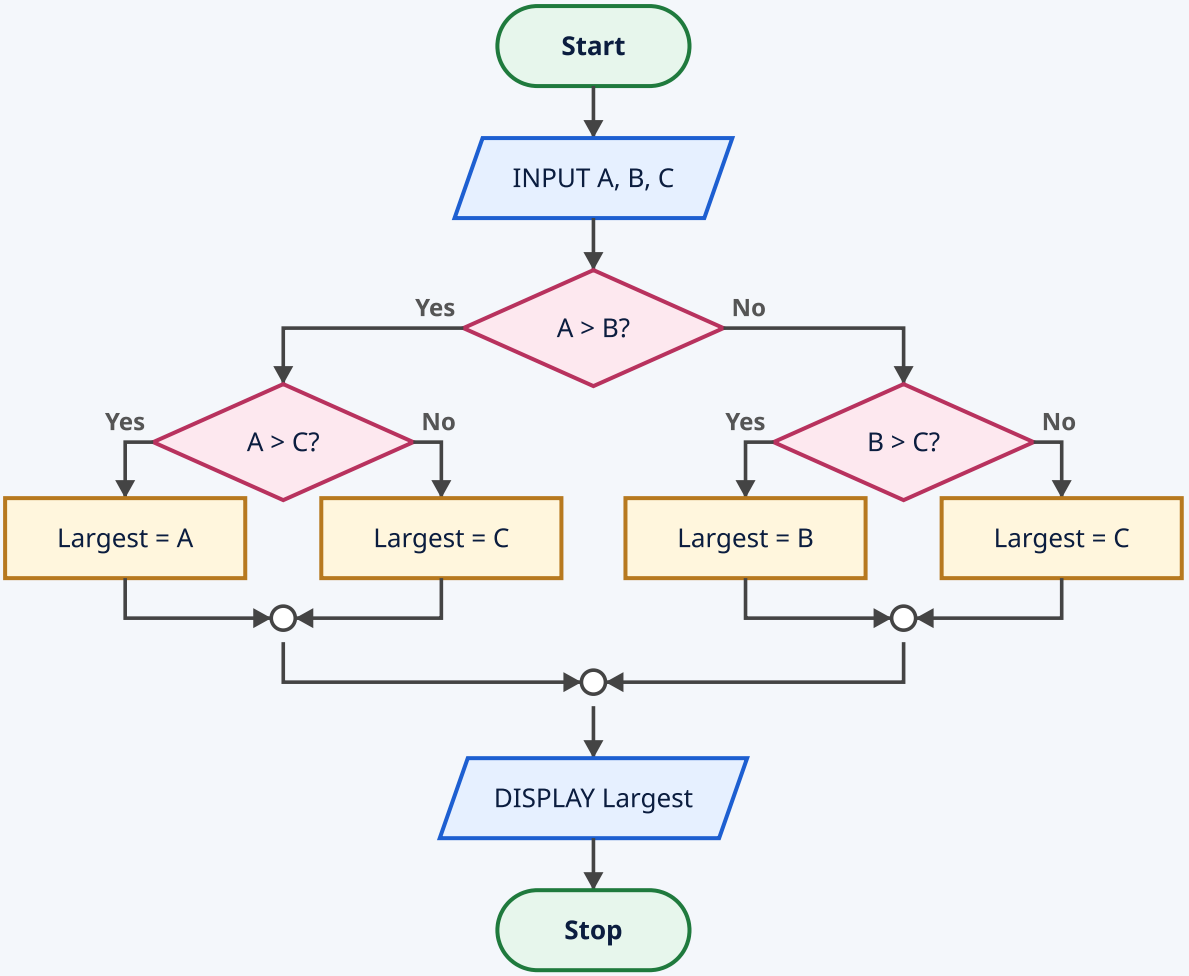
A. putting one structure inside another
B. using only sequence
C. deleting a loop
D. joining two programs

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Structured Questions

1. Draw a flowchart to input three numbers A, B and C and display the largest, using nested IFs. (5 marks) *(5 marks)*

Start/input (1); A > B? (1); Yes → A > C? (1); No → B > C? (1); assign Largest and display, Stop (1).



Flowchart – Selection inside selection: largest of three

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2. Write a program (Pascal or Python) that uses nested loops to print the triangle *, , *, **. (4 marks)** *(4 marks)*

Outer loop Row 1 to 4 (1); inner loop Col 1 to Row (1); print * without new line (1); new line after the inner loop (1).

Iteration inside iteration: star triangle

Pascal

```
program Stars;
var
  row, col: integer;
begin
  for row := 1 to 4 do
  begin
    for col := 1 to row do
      write('*');
    writeln;
  end;
end.
```

Python

```
for row in range(1, 5):
    for col in range(1, row + 1):
        print("*", end="")
    print()
```

Sample run

```
*
**
***
****
```

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3. Write pseudocode to read 5 marks and count how many are passes (≥ 35) and how many are fails. (5 marks) *(5 marks)*

PassCount = 0, FailCount = 0 (1); FOR k = 1 TO 5 (1); INPUT Mark (1); IF Mark >= 35 add 1 to PassCount ELSE to FailCount (1); display both (1).

Pseudocode

```
BEGIN
  Passes = 0
  Fails = 0
  FOR i = 1 TO 5
    INPUT Mark
    IF Mark >= 35 THEN
      Passes = Passes + 1
    ELSE
      Fails = Fails + 1
    ENDIF
  ENDFOR
  DISPLAY Passes, Fails
END
```

4. Name the four kinds of nesting and give an example of each. (4 marks) *(4 marks)*

Selection in selection – largest of three; iteration in iteration – star triangle; selection in iteration – count passes; iteration in selection – squares only for a positive number (1 each).

5. Complete a trace table for the star program (4 rows) showing Row, how many times the inner loop runs, and what is printed. (3 marks) *(3 marks)*

Row 1 → 1 → *; Row 2 → 2 → **; **Row 3** → **3** → ***; Row 4 → 4 → **** (3 for all correct).

Row	Inner loop runs (times)	Printed
1	1	*
2	2	**
3	3	***
4	4	****

Summary

- Nesting = a structure inside another.
- Nested IF: largest of three.
- Nested loop: inner loop runs fully each time.
- Inner runs = outer × inner (fixed sizes).
- IF inside a loop: count passes.
- Loop inside an IF: run only when valid.
- Indent every level; close inner first.

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- Pascal: begin … end groups statements.

MCQ answer key – 1.8

1. **C** – Nested.
2. **A** – A is biggest.
3. **D** – Outer IF.
4. **B** – 4 × 3.
5. **B** – 4 stars.
6. **A** – 1+2+3+4.
7. **C** – Inner condition.
8. **D** – 45, 78, 60.
9. **A** – IF inside FOR.
10. **D** – FOR inside IF.
11. **B** – 4 × 4.
12. **C** – Inner first.
13. **B** – begin … end.
14. **C** – Different names.
15. **A** – Definition.

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