EmSAT Achieve Computer Science- Python

Public Test Specification

Test Description: EmSAT Achieve Computer Science is a 150-minute computerized test that measures test takers' level of proficiency in Computer Science and determines their readiness for college. EmSAT Achieve Computer Science consists of two main Sections: Computer Science Theory and Problem Solving and Programming Practices. Test sections, questions, and options are randomized and timed by the test software. The computerized test is a timed test wherein the test clock is visible at all time to test takers.

Task Types		Multiple Choice	
Test Language		English	
Calculators		Not Allowed	
Content Areas		**Questions**	**Test Duration (minutes)**
Section 1: Computer Science Theory	1. Computing Systems and Networks 2. Data Analysis	35	40
Section 2: Problem Solving and Programming Practices	3. Algorithms and Programming - Python	65	110

EmSAT Achieve Computer Science	
Score	**Score Descriptors**
1500+	**High Proficiency:** students at this level are well-prepared for Computer Science courses at the university level.
1100-1475	**Proficient:** students at this level are at a satisfactory level of preparation to begin first-year Computer Science courses at the university level.
900-1075	**Borderline Proficient:** students at this level are minimally prepared for first-year Computer Science courses at the university level.
700-875	**Basic:** students at this level do not have sufficient mastery of prerequisite knowledge for first-year courses in Computer Science at the university level and may need some additional support.
500-675	**Needs Improvement:** students at this level need additional instructional support in basic Computer Science concepts and skills before beginning any first-year Computer Science courses.
< 500	**Little Knowledge of General Computer Science:** students at this level need intensive instructional support in basic Computer Science concepts and skills.

Publication Date: September 2022

EmSAT Achieve Computer Science- Python

Public Test Specification

Appendix 1: Content Areas

Below are the major sections and related content specifications that grade 12 students should be able to demonstrate mastery of in order to meet the expectations of this test.

Section 1: Computer Science Theory [35%]

This section tests the examinee knowledge in main computer science theory domains such as computer systems and network, data analysis, and impacts of computing.

1. **Computing Systems and Networks [25%]**
   Examinee should be able to:
   a. Identify the hardware components of a given computing system and describe the function of these components.
   b. Differentiate between different types of computing systems software and give examples on each software type (application software and system software).
   c. Demonstrate knowledge of how software control hardware and apply computing systems troubleshooting strategies on basic hardware and software problems.
   d. Design logic circuits and distinguish between the logic gates (AND, OR, NOT, XOR...etc.)
   e. Demonstrate knowledge of the computing trends (e.g., big data, machine learning, AI) and computing devices (e.g., microcontrollers, embedded systems ...etc.).
   f. Differentiate between different network types and recommend suitable network type for a given scenario.
   g. Differentiate between different types of network topologies and recommend suitable network topology for a given scenario.
   h. Identify different network hardware and software and demonstrate knowledge of their role in the network operation.
   i. Demonstrate knowledge of network architecture and task allocation between network hosts (Client-Server Model and Peer-to-Peer Model).
   j. Identify the network security issues and threats and apply the network security principles in network design.
   k. Demonstrate knowledge of network communication layers models and identify each layer functions and the protocols serving each layer.
   l. Identify different types of addresses and explain their role within one network communication or between different networks communication.
   m. Compare guided (wired) and unguided (wireless) transmission media in term of cost, reliability, and security.
   n. Identify the factors that affect the network performance and distinguish between the different components of nodal delay.
   o. Identify security measures designed to protect computer networks and describe vulnerabilities that the various types of cyber threats can exploit.

2. Data Analysis [10%]

Examinee should be able to:

a. Identify different data collection methods and apply these methods for locating and collecting a variety of data sets.
b. Analyze and identify patterns in a variety of data sets.
c. Identify different methods to store data and manipulate them and demonstrate knowledge of issues related to data security.
d. Identify different numbering systems and convert between numbering system to another.
e. Use the binary numbering system to represent different types of data in computers such as sound, image and text.
f. Select appropriate representations of data (e.g., charts, graphs, network diagrams, flowcharts) and use computers to model and simulate different real-life processes and phenomena.

Section 2: Problem Solving and Programming Practices [65%]

This section tests the examinee knowledge and skills in problem solving techniques and tests whether the examinee is able to use programming skills as a tool to solve computational problems.

3. **Algorithms and Programming [65%]**

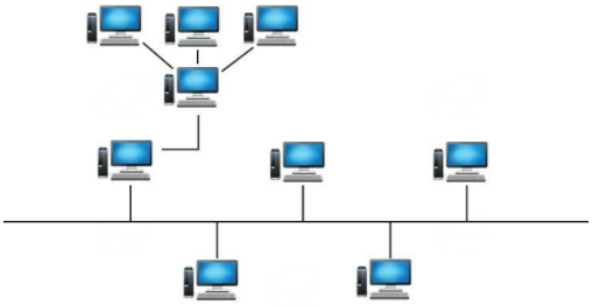
   Examinee should be able to:

   a. Break programming specifications into steps and use different algorithm representations such as pseudocodes and flowcharts to represent algorithms as first stage before coding.
   b. Evaluate and compare algorithms in term of their efficiency, simplicity, complexity, and clarity and suggest modifications to improve algorithms functionality.
   c. Apply the pillars of computational thinking as a process to solve a computational problem and select appropriate method to a given context.
   d. Create different types of variables (data types: integer, double, string...etc.) and differentiate between variables and constants in term of their roles and manipulation.
   e. Distinguish between different operators (arithmetic, logical and relational) and evaluate simple and compound expressions.
   f. Create different static data structures and perform different operations (update, swap, research...etc.) on them in order to manipulate their elements or extract information.
   g. Read and write data from external data structures such as files and decide when it is appropriate to use external data structure.
   h. Create different dynamic data structures and perform different operations (update, swap, research...etc.) on them in order to manipulate their elements or extract information.
   i. Program using Procedure-Oriented Programming (POP) and create different types of functions based on whether they accept arguments and/or return values.
   j. Program using Object-Oriented Programming (OOP) and be able to apply the features of the OOP such as inheritance, encapsulation, abstraction, and polymorphism.
   k. Combine sequence steps of instructions in order to achieve a specific task.
   l. Distinguish between different selection statements (If Statement, If-Else Statement, Nested If-Statement, Switch/Case) and select the appropriate selection statement based on the problem given.
   m. Distinguish between different iteration statements (For Loop, While Loop, Do-While Loop) and select the appropriate iteration statement based on the problem given.
   n. Compare and contrast different high-level programming languages and identify the main components of the programming environment.
   o. Combine all programming constructs (sequence, selection, and iteration) and components (variables, control structures, operators, functions...etc.) together in order to build a program that meets certain design specifications.
   p. Identify different types of programming errors (runtime, syntax and logical) and apply different testing techniques to ensure program correctness.
   q. Apply programming best practices when coding and produce well documented program that is easy to read, reuse and maintain.

EmSAT Achieve Computer Science- Python
Public Test Specification

Appendix 2: Sample Items

1. What is this network topology of the following computer network?



A. a hybrid network topology

B. a linear network topology

C. an interconnected network topology

D. a branched network topology

2. Which of the following is **not** an IP address?

A. 260.1.0.5

B. 244.193.55.13

C. 8.8.8.8

D. 1.0.0.1

3. Which of the following is **not** an operating system?

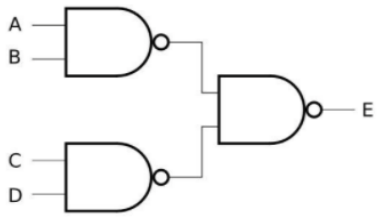
A. MS Office 365

B. Linux

C. Android

D. Macintosh

4. Which of the following Boolean expressions is equivalent to the following digital logic circuit?



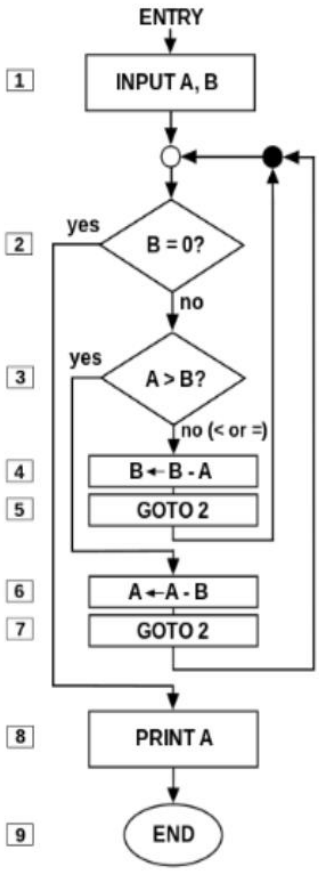
A. $E = A.B + C.D$

B. $E = (\overline{A.B} + \overline{C.D})$

C. $E = (\overline{A.B + CD})$

D. $E = \overline{((A + B).(C + D))}$

5. Given the following algorithm (flowchart), what is the output of the last statement, **PRINT A**, if the inputs are A = 78, and B = 12?



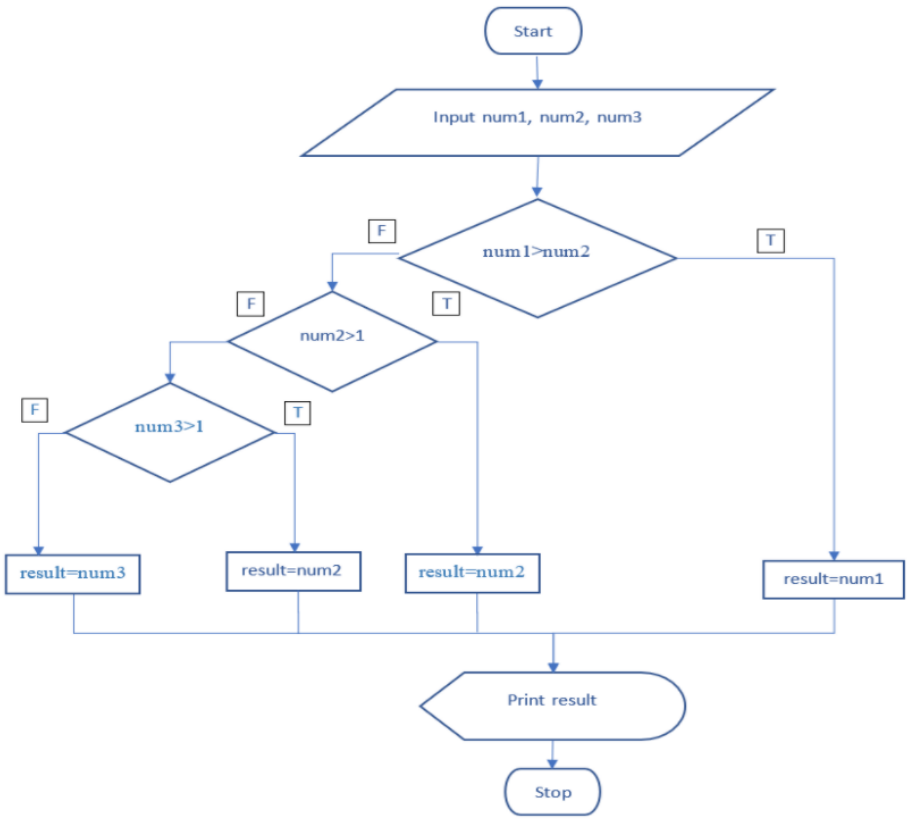
A. 6

B. 7

C. 66

D. 78

6. What is the output of the following algorithm (flowchart) if the inputs are num1 = -1, num2 = 0, and num3 = 6?



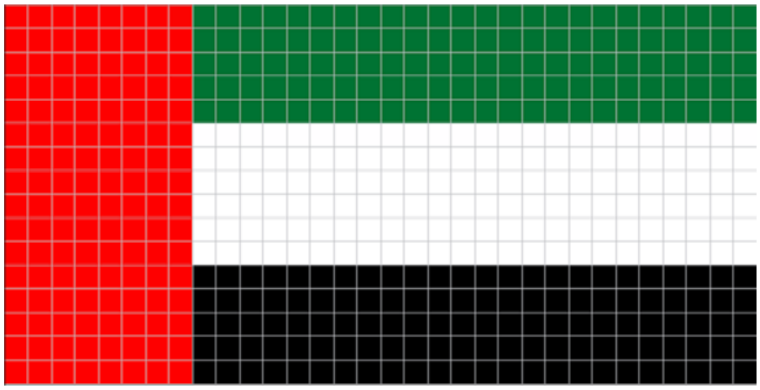
A. 0

B. -1

C. 6

D. 1

7. What is the size (in bytes) of the following 32×16 image with 16-bit color code?



A. 1024 bytes

B. 512 bytes

C. 96 bytes

D. 128 bytes

8. What is the output of the following code?

```
A=[1,4,2,0,3]
temp = A[0]

for i in range(len(A)-1):
    A[i]=A[i+1]

A[len(A)-1]=temp

for i in range(len(A)):
   print (A[A[i]],end = '')
```

- 10432
- 42031
- 30241
- 31420

9. What is the output of the following code?

```
s="UAE2019"
t=""
for i in range(len(s)):
    t = s[i] + t
print(t)
```

- ○ 9102EAU
- ○ 2019UAE
- ○ UAE2019
- ○ UAE20199102EAU

10. Given the following recursive function:

```
def recursive(n):
    if (n <= 2):
        return n
    else:
        return (n + recursive(n-1) + recursive(n-2))
```

What is the output of the following function call?

```
print( recursive(5))
```

- ○ 23
- ○ 19
- ○ 16
- ○ 0

11. What is the output of the following statement?

```
print((1.0 - 6 * 4 / 5 ) /  (17 % 5))
```

- ○ −1.9
- ○ −1
- ○ −2
- ○ −1.5

12. What is the output of the following statement?

```
print(2**3+28%9*5)
```

- ○ 13
- ○ 46
- ○ 54
- ○ 24

Answer Key:

1. A
2. A
3. A
4. A
5. A
6. A
7. A
8. A
9. A
10. A
11. A
12. A

Appendix 2: EmSAT Pseudocode Guide

Section 1: Variables and Data Types

Action	Rule	Example
Variable declaration	**int** variable_name **double** variable_name **char** variable_name **string** variable_name	**int** x **double** weight **char** vitamin **string** name
Variable declaration and initialization	**data_type** variable name ← value	**int** x ← 3 **char** vitamin ← 'A' **string** name ← "Wafa"
Passing value to a variable	variable ← value	x ← 6 name ← "Wafa" vitamin ← 'C'
Incrementing the value of a variable	variable ← variable +1	x ← x+1
Decrementing the value of a variable	variable ← variable -1	x ← x-1
Moving the value of a variable to another variable	Variable_2 ← variable_1	y ← x

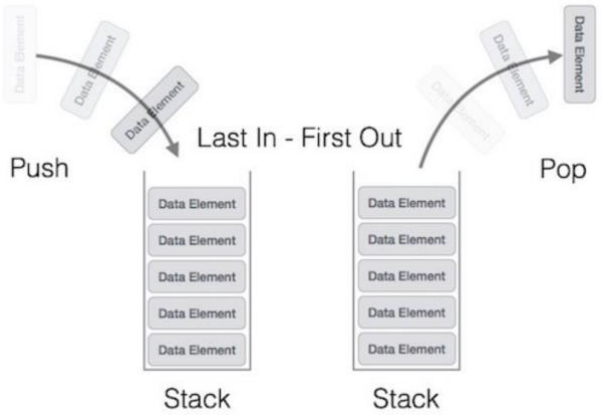
Section 2: Static and Dynamic Data Strucutres

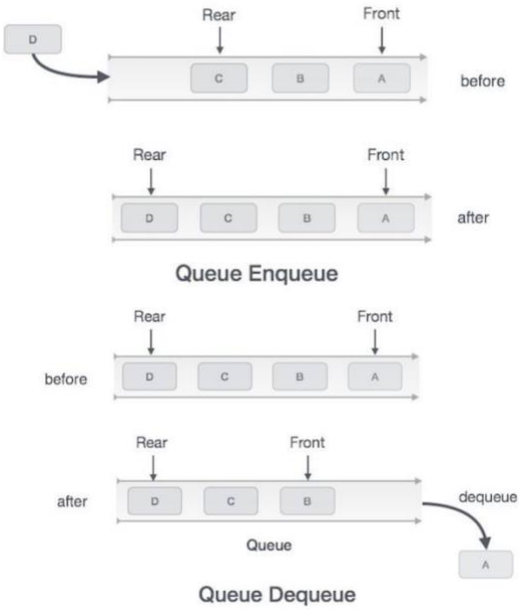
Data Structure		Rule	Example
Static 1D Array	**Declaration and Initialization**	**data_type** array_name [] ← {element 1, element 2, element N}	**int** grade [] ← {88, 83, 99} **double** temp [] ← {33.2, 37.1, 39.2} **string** name [] ← {"Wafa", "Nafla", "Rola"}
	Update	array_name [index]← value	**int** grade [] ← {88, 83, 99} grade [1]← 84 // replace 83 with 84

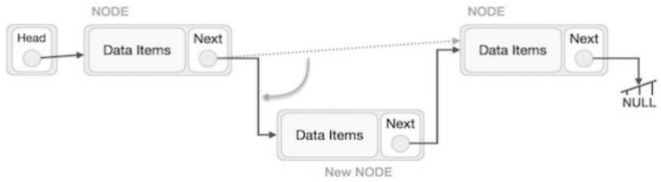
	Search	**data_type** array_name [] ← {element 1, element 2, element N}
		FOR (**int** i ← 0, i<N, i ← i+1)
		IF (array_name [i] == value)
		PRINT "found"
		ELSE
		PRINT "not found"
		END IF
		END FOR
			int grade [] ← {88, 83, 99}
			FOR (**int** i ← 0, i<3, i ← i+1)
			IF (grade [i] == 83)
			PRINT "found"
			ELSE
			PRINT "not found"
			END IF
			END FOR

	Swap	array_name [index_target]← array_name [index_source]	**int** grade [] ← {88, 83, 99}

<table>
<tr><td></td><td></td><td></td><td></td><td>grade [1]← grade [2] // swap 83 with 99</td></tr>
<tr><td>Static 2D Array</td><td colspan="2">Declaration and Initialization</td><td>data_type array_name [][]
FOR (int i ← 1, i<N, i ← i+1)
  FOR (int j ← 1, (j<N), j ← j+1)
  array_name [i][j]← value
  END FOR
END FOR</td><td>int 2D_multiplication [][]
FOR (int i ← 1, i<10, i ← i+1)
  FOR (int j ← 1, j<10, j ← j+1)
  2D_multiplication [i][j]← i*j
  END FOR
END FOR</td></tr>
<tr><td></td><td colspan="2">Update</td><td>data_type array_name [][]
FOR (int i ← 1, i<N, i ← i+1)
  FOR (int j ← 1, j<N, j ← j+1)
  array_name [i][j]← value
  END FOR
END FOR</td><td>int 2D_multiplication [][]
FOR (int i ← 1, i<10, i ← i+1)
  FOR (int j ← 1, j<10, j ← j+1)
  2D_multiplication [i][j]← i*j
  END FOR
END FOR</td></tr>
<tr><td></td><td colspan="2">Search</td><td>data_type array_name [][]
FOR (int i ← 1, i<N, i ← i+1)
  FOR (int j ← 1, j<N, j ← j+1)
  IF (array_name [i][j]← value)
  PRINT “found”
  ELSE
  PRINT “not found”
  END IF
  END FOR
END FOR</td><td>int 2D_multiplication [][]
FOR (int i ← 1, i<N, i ← i+1)
  FOR (int j ← 1, j<N, j ← j+1)
  IF (2D_multiplication [i][j]← 30)
  PRINT “found”
  ELSE
  PRINT “not found”
  END IF
  END FOR
END FOR</td></tr>
<tr><td>Dynamic Data Structure</td><td>Stack</td><td>Basic Operations</td><td>PUSH () – Pushing (storing) an element on the stack.
IF stack isFULL
  RETURN NULL
END IF
Top ← top + 1
stack[top] ← data

POP () – Removing (accessing) an element from the stack.
IF stack isEMPTY
  RETURN NULL
END IF
data ← stack[top]
top ← top - 1</td><td> 
</td></tr>
</table>

	Queue	**Basic Operations**	**ENQUEUE ()** – add (store) an item to the queue.
			IF queue **isFULL**
			  RETURN OVERFLOW
			END IF
			Rear ← rear + 1
			queue[rear] ← data
			DEQUEUE () – remove (access) an item from the queue.
			IF queue **isEMPTY**
			  RETURN UNDERFLOW
			END IF
			data ← queue[front]
			front ← front + 1
				

	Linked List	**Insertion Operation**	NewNode.Next → RightNode LeftNode.Next → NewNode	
		Deletion Operation	LeftNode.Next → TargetNode.Next TargetNode.Next → NULL	

Section 3: Operators and Expressions

Operator	Rule	Example
Arithmetic	+, - , *, %, /, ^ **Note:** / indicates floating point division unless stated otherwise	**int** r formula ← 2*PI*r^2

Relational	**>, <, ==,** ≠, ≤, ≥,	**int** value_1
		int value_2
		READ value_1, value_2
		IF (value_1 > value_2)
		  PRINT "value_1 is bigger than value_2"
		ELSE
		  PRINT "value_1 is smaller than value_2"
		END IF

Logical	AND, OR, NOT	**int** x
		READ x
		IF (x ≠ 0 and x>0) // print the value if its zero or positive
		  PRINT x
		ELSE
		  PRINT "entry is negative"
		END IF

Section 4: Iteration

Loop	Rule	Example

While Loop	counter initialization
	WHILE (condition)
	  statement/s
	  increment counter
	END WHILE
		int value ←1
		WHILE (value ≠ 6)
		  PRINT value
		  value ← value+1
		END WHILE

Do while	counter initialization
	DO
	  statement/s
	  increment counter
	WHILE (condition)
		int i ← 1
		DO
		  PRINT "Hello World!"
		  i ← i+1
		WHILE (i<10)

For Loop	**FOR** (initialization, (condition), increment)
	  statement/s
	END FOR
		FOR (**int** i ← 0; (i <10); i ← i+1)
		  PRINT i
		END FOR

Nested For Loop	**FOR** (initialization, (condition), increment)
	  FOR (initialization, (condition), increment)
	  statement/s
	  END FOR
	END FOR
		FOR (**int** i ← 1, (i<10), i ← i+1)
		  FOR (**int** j ← 1, (j<10), j ← j+1)
		  PRINT i+j
		  END FOR
		END FOR

Section 5: Selection

Selection	Rule	Example

If Statement	**IF** (condition)
	  statement/s
	END IF
		int value
		READ value
		IF (value ≠ 0)
		  PRINT value
		END IF

If Else Statement	**IF** (condition)
	  statement/s
	ELSE
	  statement/s
	END IF
		int value_1
		int value_2
		READ value_1
		READ value_2
		IF (value_1 > value_2)
		  PRINT “value_1 is bigger than value_2”
		ELSE
		  PRINT “value_1 is smaller than value_2”
		END IF

Nested If Statement	**IF** (condition)
	  statement/s
	ELSE
	  IF (condition)
	  statement/s
	  ELSE
	  IF (condition)
	  statement/s
	  ELSE
	  statement/s
	  END IF
	  END IF
	END IF
		int grade
		READ grade
		IF (grade ≥ 90)
		  PRINT “grade is A”
		ELSE
		  IF (grade ≥ 80)
		  PRINT “grade is B”
		  ELSE
		  IF (grade ≥ 70)
		  PRINT “grade is C
		  ELSE
		  PRINT “grade is F”
		  END IF
		  END IF
		
		END IF

Switch	**data_type** value
	READ value
	  CASE 1: (condition 1)
	  statement/s
	  CASE 2: (condition 2)
	  statement/s
	  CASE 3: (condition 3)
	  statement/s
	  CASE N: (condition N)
	  statement/s
	  DEFAULT
	  statement/s
	END CASE
		int grade
		READ grade
		  CASE 1: (grade ≥ 100)
		  PRINT “perfect score”
		  CASE 2: (grade > 89)
		  PRINT “grade is A”
		  CASE 3: (grade > 79)
		  PRINT “grade is B”
		  CASE 4: (grade > 69)
		  PRINT “grade is C”
		  CASE 5: (grade > 59)
		  PRINT “grade is D”
		  DEFAULT
		  PRINT “grade is F”
		END CASE

Section 5: Procedure-Oriented Programming

Function Body		**Rule**	**Example**
returns	**arguments**		

x	**x**	**void FUNCTION** function_name ()
		  statement/s
		END FUNCTION function_name
			void FUNCTION greetings ()
			  PRINT “Hello”
			END FUNCTION greetings

x	**√**	**void FUNCTION** function_name (arg1, arg2….)
		  statement/s
		END FUNCTION function_name
			void FUNCTION greetings (customer_name)
			  PRINT “Hello, customer_name”
			END FUNCTION greetings

√	**x**	**data_type FUNCTION** function_name ()
		  statement/s
		  RETURN value
		END FUNCTION function_name
			string FUNCTION myname ()
			  name ← “Wafa”
			  RETURN name
			END FUNCTION myname

√	**√**	**data_type FUNCTION** function_name (arg1, arg2…)
		  statement/s
		  RETURN value
		END FUNCTION function_name
			int FUNCTION multiplication (value_1, value_2)
			  result ← value_1 * value_2
			  RETURN result
			END FUNCTION multiplication

Function Call		**Rule**	**Example**
returns	**arguments**		
x	**x**	function_name ()	greetings ()
x	**√**	function_name (arg1, arg2, argN)	greetings (Wafa)

√	x	function_name ()	myname ()
√	√	function_name (arg1, arg2, argN)	multiplication (10, 3)

Section 6: Object-Oriented Programming

Actions	Rule	Example
Class declaration	**CLASS** class_name **variable declarations** **functions** **END CLASS** class_name	**CLASS** student **string** name **double** GPA **int** Grade **void** register () **void** drop () **END CLASS** student
Object Creation	**Object_name** class_name	**std1** student

Section 7: Others

Boolean	TRUE, FALSE
Null	NULL
Comments	// type the comments here
Placeholder for missing code	/* missing code */ /* condition */
Keywords	READ RETURN PRINT DEFAULT SIZE LENGTH CASE PI Void BREAK TRUE FALSE

	WRITE SQUARE
Data Types	int double char string float