



## EmSAT Achieve Computer Science- C++ Public Test Specification

**Test Description:** EmSAT Achieve Computer Science is a 120-minute computerized test that measures the test takers' level of proficiency in computer science and determines their readiness for college. EmSAT Achieve Computer Science consists of five major domains: (1) Computing Systems; (2) Computer Networks; (3) Computational Thinking; (4) Programming and Problem Solving; and (5) Impact of Computing. 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 times to test takers.

<b>Test Duration:</b>	120 minutes
<b>Questions:</b>	100 questions
<b>Content Areas:</b>	<ol style="list-style-type: none"><li>1. Computing Systems</li><li>2. Computer Networks</li><li>3. Computational Thinking</li><li>4. Programming and Problem Solving (C++)</li><li>5. Impact of Computing</li></ol>
<b>Task Types:</b>	Multiple Choice
<b>Calculators</b>	Not Allowed

EmSAT Achieve Computer Science	
Score	Score Descriptors
1500+	<b>High Proficiency:</b> students at this level are well-prepared for Computer Science courses at the university level.
1100-1475	<b>Proficient:</b> students at this level are at a satisfactory level of preparation to begin first-year Computer Science courses at the university level.
900-1075	<b>Borderline Proficient:</b> students at this level are minimally prepared for first-year Computer Science courses at the university level.
700-875	<b>Basic:</b> 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	<b>Needs Improvement:</b> students at this level need additional instructional support in basic Computer Science concepts and skills before beginning any first-year Computer Science courses.
< 500	<b>Little Knowledge of General Computer Science:</b> students at this level need intensive instructional support in basic Computer Science concepts and skills.



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### 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: Computing Systems

This section includes what makes a computer: input and output devices, memory, processing units (CPU). It focuses on how inputs insert information to the computer and how the output provides the desired result after processing all the information using the central processing unit that all computers have in common. It focuses on how software controls the hardware of a computer whether it is application software (such as MS Word) that provides a service to the computer user, or system software (Windows) that manages different types of computer resources. This domain also gives an overview of how the hardware of a computer is designed and represented using different methods such as truth tables, Boolean expressions, and Venn diagrams. It focuses on how programmers talk to computers using high-level programming languages and the role of translators to translate these commands to the language that computers understand, zeros and ones (binary). Since binary is the language that computers understand, this domain focuses on how to represent different types of data such as numbers, images, sound, and text using binary representation and how the binary numbering system can be obtained and converted from other numbering systems such as the denary numbering system and the hexadecimal numbering system.

#### Content Specifications

- Differentiate between input and output devices and relate them to their functions in a given computing system
- Identify the elements of the CPU and illustrate how these elements support the Machine Instruction Cycle
- Differentiate between different types of memory in term of cost, size, capacity, access time and type of data stored (permanent and temporary)
- Identify computer peripherals (sound card, motherboard, etc.) and recognize their role in the function of computers
- Illustrate the operations of logic, logic circuits, and their representations
- Identify different types of software and explain their roles in terms of functionality
- Differentiate between the features of high- and low-level programming languages and identify different types of program translators
- Represent numbers using different numbering systems and perform conversions across different numbering systems
- Apply different techniques to make binary representations for default types of data including data compression (numbers, text data, binary data).
- Identify the malicious activities and security risks which cause data loss, threaten data integrity, and data privacy and Identify the malicious activities and security risks causing data loss, threaten data integrity, data privacy and devise counterpart measures.



## Section 2: Computer Networks

This section includes the characteristics and properties of different types of networks. It focuses on how different network types and hosts within a network are arranged relative to each other and the different transmission modes that the network hosts use for these arrangements. It focuses on the network end-systems and how hosts can be either clients or servers based on the tasks that are allocated to them. It focuses on the wired and wireless links (transmission media) that connect hosts to each other and how different properties of these transmission media affect the data transmission speed in a network. It also includes the methods of data switching within a network and the role of different types of network addresses in data transfer within different types of networks.

### Content Specifications

- Differentiate between different types of networks (LAN, WLAN, WAN, internet, etc.) and recommend suitable network types for a given scenario
- Differentiate between different topologies (Bus topology, Star topology, Ring topology, Mesh topology, Tree topology, hybrid, etc.) and recommend suitable network topologies for a given scenario
- Identify different network hardware (switch, router, network interface card (NIC)) and software (OS) and demonstrate their role in network operation
- Illustrate how computers are organized in a network and how tasks are allocated between these computers (Client-Server Model and Peer-to-Peer Model)
- Demonstrate how communication over networks is broken down into different layers and identify protocols in each layer
- Identify different types of addresses (IP address, MAC address) and demonstrate their role in computer communication over different types of networks
- Compare different transmission media (wired and wireless) in term of cost, reliability, security, and speed and specify the factors that affects data transmission speed
- Demonstrate an understanding of how data is transmitted across networks and identify the factors that affect the efficiency and validity of data transmission
- Identify security measures designed to protect stand-alone and networked computer systems and to protect the security of data
- Identify different types of cyber threats and describe vulnerabilities that various types of cyber threats can exploit.



### **Section 3: Computational Thinking**

This section includes the computational thinking techniques that help us understand problems and the ways in which they can be resolved, and then use the computer (programming) to solve them more efficiently. These techniques are Algorithm, Decomposition, Abstraction, and Pattern Recognition. This domain focuses on how these techniques can be used to evaluate, break down, and solve complex problem.

#### **Content Specifications**

- Design and represent algorithms using different methods of representation such as pseudocodes and flowcharts
- Evaluate algorithmic solutions in terms of complexity, efficiency, correctness, reliability, and flexibility and find the output(s) of an algorithm based on the input(s)
- Decompose problems into smaller sub-problems in order to manage the complexity of a given problem and show how sub-problems are interrelated
- Identify abstraction in real-life examples and demonstrate how abstraction helps to manage problem complexity
- Identify patterns and illustrate how generalizing these patterns help in solving problems that are more complex



#### **Section 4: Programming and Problem-Solving**

This section includes the essentials and basics of programming skills, including breaking down code into interrelated modules, controlling the execution of programs using different types of control structure statements, usage of built-in functions, and the appropriate selection of complex or simple data structures. It also focuses on good programming skills and the proper methods of testing and debugging. This domain also focuses on problem-solving skills and how they are used to solve simple life problems using programming.

#### **Content Specifications**

- Decompose a complex program into functions (well-defined tasks) and state how these functions interact with each other.
- Use built-in functions to manipulate different data structures, format input and output data, and decide whether to use predefined functions or user-defined functions.
- Declare and manipulate variables and data structures within a program.
- Manipulate data structures and use them to hide the complexity of the problem.
- Read and write data from external data structures such as files and decide when it is appropriate to use external data structures.
- Select appropriate control structures and decision-making logic expressions to control the flow of program execution.
- Evaluate expressions and manipulate different numeric and non-numeric data types
- Combine programming concepts to solve a given problem.
- Test a program to identify and correct different types of errors in different software development stages.
- Implement programming best practices when coding to make codes easy to read, test, debug, and maintain.



## Section 5: Impact of Computing

This section includes the impacts of computing concepts that students need to know before they move on to higher education. This includes how technology has changed different aspects of our lives in different contexts such as health, education, environment, culture, social life, and workplaces. This section also covers principles of ethics and laws that protect copyright and ownership, and the proper use of the internet especially when it comes to digital privacy and how improper use of the internet puts the internet user at risk of cyber-attacks and threats. It also focuses on the cyber-security methods and tools that are used to protect computer systems, whether standalone computers or networked computers from vulnerabilities that various types of cybersecurity threats can exploit.

### Content Specifications

- Illustrate the importance of ownership and copyright laws of software and data, and identify how modern technologies ('copy and paste', file-sharing) make it easy to break ownership laws
- Identify principles of ethics and professional practices at workplaces and schools and apply them to real life situation.
- Apply best practices of the proper use of technology and investigate how digital privacy is governed across the globe.
- Evaluate the usability of computational artifacts such as devices, software, websites, etc. and the use of tools and methods for collaboration across different cultures.
- Recognize the consequences of the 'digital divide' (having unequal access to computing resources) on education, entertainment, and income, and identify the factors that affect the digital divide such as laws, living standard, etc.
- Recognize the positive and negative effects of technology on society, including different aspects such as health, safety, education, social interaction, culture, and activities, and propose solutions to reduce negative impacts.
- Recognize the positive and negative effects of technology on personal lifestyle, privacy, safety, health, etc.
- Describe how computational innovations have evolved and resulted in a revolutionized aspect of society.



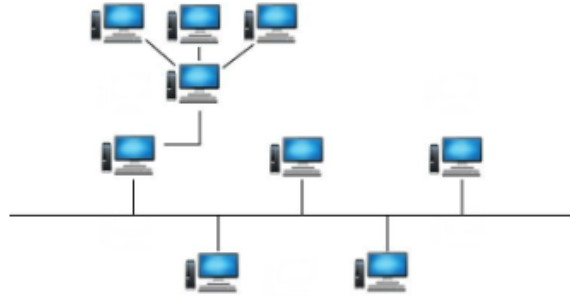
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### Appendix 2: Sample Items

1.

The following figure shows a network of devices connected together. It is best described as

المخطط التالي يوضح شبكة من الأجهزة المتصلة ببعضها. الوصف الأفضل أنها



- A. a hybrid network topology      طبولوجيا الشبكة الهجينة
- B. a linear network topology      طبولوجيا الشبكة الخطية
- C. an interconnected network topology      طبولوجيا الشبكة المترابطة
- D. a branched network topology      طبولوجيا الشبكة المتفرعة

2.

Which of the following is **NOT** an IP address?

أي من الآتي ليس عنوان IP؟

- A. 260.1.0.5      B. 244.193.55.13
- C. 8.8.8.8      D. 1.0.0.1



3.

A compiler is best described as a tool that

أفضل وصف للمترجم هو أداة

- A. converts high level programming languages into a machine language. تُحول لغات البرمجة ذات المستوى العالي إلى لغة الآلة
- B. checks program written in any programming language for errors. تُستخدم لفحص الأخطاء في البرنامج المكتوب في أي لغة برمجة
- C. assembles program components to make them ready for execution. تجمع مكونات البرنامج لجعلها جاهزة للتنفيذ
- D. translates intermediate programs, such as interpreted codes, into machine language. تُترجم البرامج المتوسطة، مثل التعليمات البرمجية التفسيرية إلى لغة الآلة

4.

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

أي من الآتي ليس نظام تشغيل؟

- A. MS Office 365 ميكروسوفت أوفيس 365
- B. Linux لينكس
- C. Android أندرويد
- D. Macintosh ماكنتوش

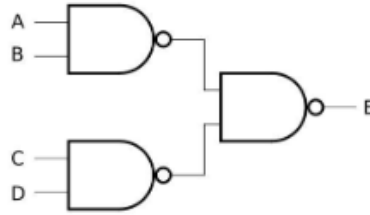




5.

The following digital logic circuit shows E as a function of A, B, C, and D. Which algebraic form is the correct one for E?

الدائرة الرقمية المنطقية التالية تشير إلى العلاقة بين E وكل من A و B و C و D . ما هو التعبير الجبري الصحيح ل E ؟



A.

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

B.

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

C.

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

D.

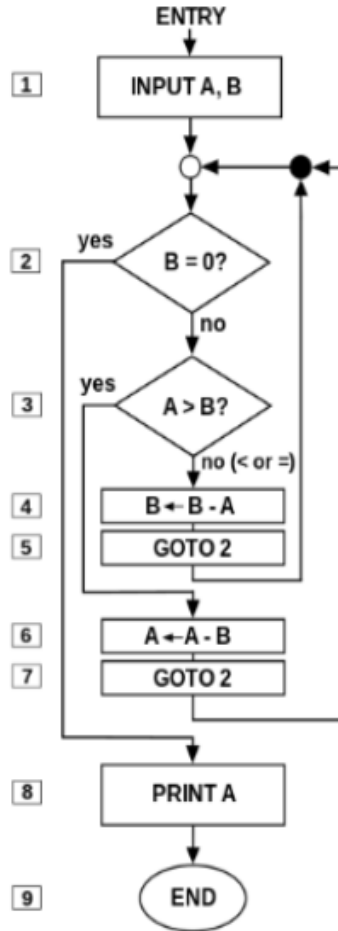
$$E = \overline{((A + B).(C + D))}$$



6.

Given the algorithm shown in the figure, What will be printed by the last statement, PRINT A, if the input A = 78, and B = 12?

أعطيت الخوارزمية المُشار إليها بالمخطط، ما الذي سوف يُطبع من آخر عبارة برمجية، print A، إذا أدخلت القيم التالية A=78 و B=12؟



A.

B.

C.

D.



7. Dividing an essay into three sections as shown below uses which computational thinking pillar?

تقسيم المقال إلى ثلاثة أقسام كما هو موضح  
يستخدم أي من أسس التفكير الحسابي؟  
(computational thinking pillar)

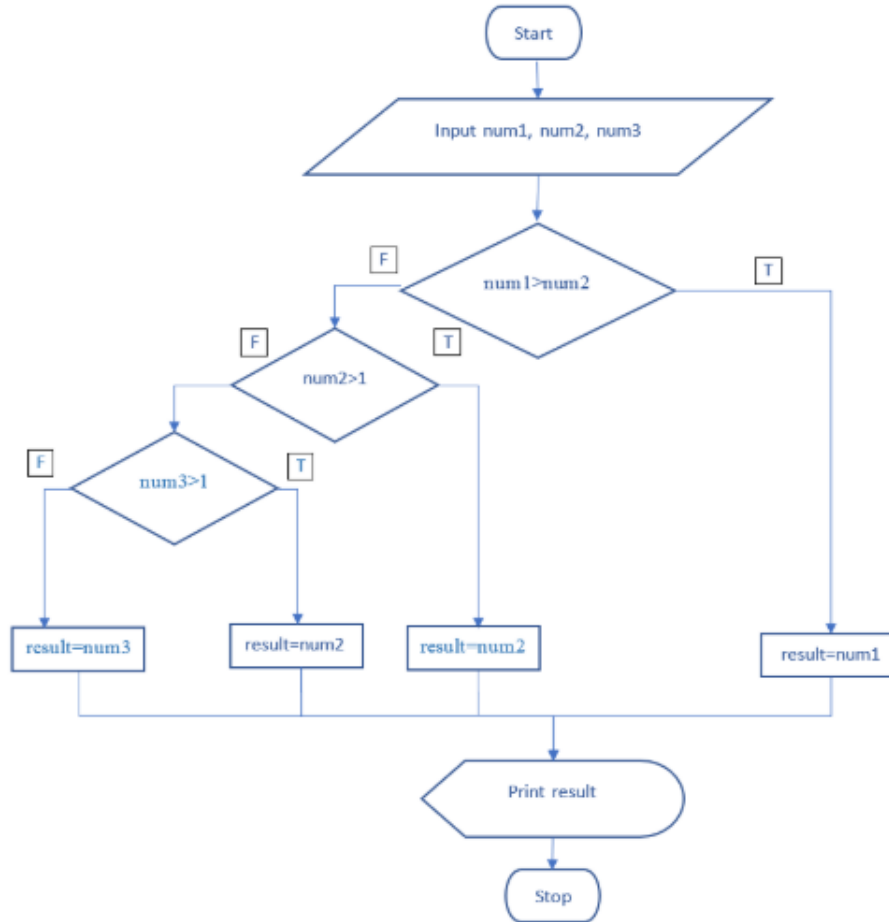
- I. Introduction
  - A. Topic Sentence:
  - B. Thesis Statement:
- II. Body
  - A. Topic Sentence 1:
    - 1. examples:
  - B. Topic Sentence 2:
    - 1. examples:
  - C. Topic Sentence 3:
    - 1. examples:
- III. Conclusion
  - A. Summary:
  - B. Restate Thesis:

- A. Decomposition التفكير
- B. Abstraction التجريد
- C. Patterns recognition تمييز الأنماط
- D. Algorithmic thinking التفكير الخوارزمي



8. Evaluate the result of the following flowchart if the inputs are  $\text{num1} = -1$ ,  $\text{num2} = 0$ , and  $\text{num3} = 6$ :

قيم نتيجة المخطط الانسيابي التالي اذا قام المستخدم بإدخال  $\text{num1} = -1$  و  $\text{num2} = 0$  و  $\text{num3} = 6$



- A.
- B.
- C.
- D.



9.

The pseudocode below uses which of the following algorithm components?

شبه التعليمات البرمجية (pseudocode) أدناه تستخدم أي من وحدات بناء الخوارزمية (algorithm components)؟

FOR side FROM 1 TO 4:  
turnRight(45) forward(length)

- A. Iteration تكرار
- B. Invocation استدعاء
- C. Selection اختيار
- D. Sequence تتابع

10.

Which of the following is **not** one of the purposes of a digital signature?

أي مما يلي لا يُعدُّ من أهداف التوقيع الرقمي؟

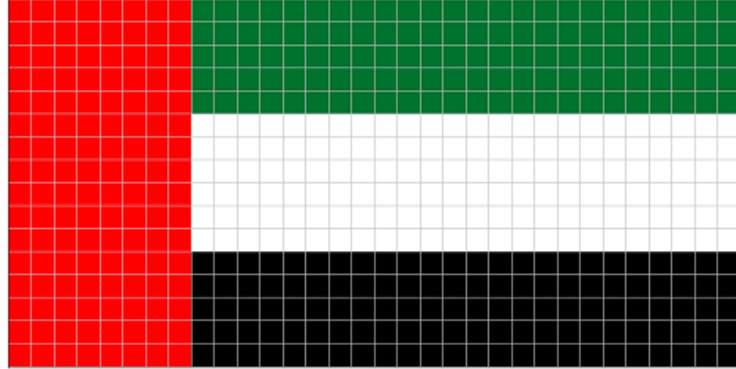
- A. Verify the date and the time the message was created and sent التحقق من تاريخ ووقت إنشاء وإرسال الرسالة
- B. Verify that the message was created and sent by the intended sender التحقق من أن الرسالة تم إنشاؤها وإرسالها من قِبَل المُرسِل المقصود.
- C. Ensure that the message was not altered in transit. التأكد من أنه لم يتم تغيير (تزوير) الرسالة أثناء النقل.
- D. Ensure that the sender can not deny sending the message. التأكد من أن المُرسِل لن ينكر إرساله للرسالة.



11.

Analyze the following 32×16 image with 16-bit color code to compute its size in bytes.

حلّل الصورة 32x16 بنظام رمز اللون bit-16  
لحساب حجمها بالبايت (bytes).



- A.
- B.
- C.
- D.

12.

What will be the output of the following code?

ماذا سيكون مُخرج التعلّيمَة البرمجية التالية؟

```
int A[ ] = {1,4,2,0,3};  
int temp = A[0];  
for(int i=0; i< 4; i++)  
    A[i] = A[i+1];  
A[4] = temp;  
for(int i=0; i< 5; i++) cout<< A[ A[i] ];
```

- 
-



13.

What will be the output of the following code?

ماذا سيكون مُخرج التعلّمة البرمجية التالية؟

```
string s="UAE2019";  
string t="";  
for(int i = 0; i < s.length(); i++)  
    t = s[i] + t;  
cout << t << endl;
```

9102EAU

2019UAE

UAE2019

UAE20199102EAU

14.

What will be the output of the following function call

ماذا سيكون مُخرج الدالة البرمجية التالية؟

```
cout<< recursive(5) <<endl;
```

if the function recursive is defined as follows?

إذا تم تعريف الدالة البرمجية التكرارية كما يلي ؟

```
int recursive(int n)  
{  
    if (n <= 2)  
        return n;  
    else  
        return n + recursive(n-1) + recursive(n-2);  
}
```

23

19

16

0



15.

Which of the following is **NOT** a correct method to create an array of 5 integers?

أيّ الآتي يُعتبر طريقة غير صحيحة لإنشاء صف مُكوّن من 5 أرقام صحيحة؟

```
int a[5];  
a = {1,2,3,4,5};
```

```
int* a = new int[10];
```

```
int a[5] = {0};
```

```
int a[5];
```

16.

Evaluate the following expression:

قيم العبارة البرمجية التالية:

```
cout<< (1.0 - 6 * 4 / 5) / (17 % 5) <<endl;
```

-1.5

-1

-2

-1.9

17.

Compute the following arithmetic expression:

احسب العبارة الحسابية التالية:

```
17%4+28%9*67
```

68

86

67

78





**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
13. A
14. A
15. A
16. A
17. A

