

# Academic Challenge



EASTERN ILLINOIS UNIVERSITY

## 2019 Academic Challenge

### COMPUTER SCIENCE TEST – SECTIONAL

Computer Science Test Production Team

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#### GENERAL DIRECTIONS

Please read the following instructions carefully. This is a timed test; any instructions from the test supervisor should be followed promptly.

The test supervisor will give instructions for filling in any necessary information on the answer sheet. Most Academic Challenge sites will ask you to indicate your answer to each question by marking an oval that corresponds to the correct answer for that question. One oval should be marked to answer each question. Multiple ovals will automatically be graded as an incorrect answer.

Be sure ovals are marked as  , not  ,  ,  , etc.

If you wish to change an answer, erase your first mark completely before marking your new choice.

You are advised to use your time effectively and to work as rapidly as you can without losing accuracy. Do not waste your time on questions that seem too difficult for you. Go on to the other questions, and then come back to the difficult ones later if time remains.

**Time: 40 Minutes**

**Number of Questions: 30**

**DO NOT OPEN TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO!**

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Academic Challenge  
Computer Science (Sectional) - 2019

Use the following code for questions 1-5.

```

1 #include <iostream>
2 #include <vector>
3 using namespace std;
4
5 template <class T>
6 class list
7 {
8     public:
9         virtual void Add(T val)           = 0;
10        virtual T    Get(int index) const = 0;
11        virtual int  Length()             const = 0;
12 };
13
14 template <class T>
15 class CircularArray : public list<T>
16 {
17     private:
18         T mem[100];
19         int curIndex;
20     public:
21         CircularArray()           { curIndex = 0;           };
22         void Add(T val)           { mem[curIndex++ % 100] = val; };
23         T    Get(int index) const { return mem[index % 100]; };
24         int  Length()             const { return curIndex; };
25 };
26
27 template <class T>
28 class VectorList : public list<T>
29 {
30     private:
31         vector<T> mem;
32     public:
33         VectorList()           { };
34         void Add(T val)           { mem.push_back(val); };
35         T    Get(int index) const { return mem[index]; };
36         int  Length()             const { return mem.size(); };
37 };

```

*Code continues on next page.*

```

38 template <class T>
39 void DumpList(const list<T> &a)
40 {
41     int tmp = 0;
42     while(tmp < a.Length())
43         cout << a.Get(tmp++) << " ";
44     cout << endl;
45 }
46
47 int main()
48 {
49     CircularArray<int> a = CircularArray<int>();
50     VectorList<int>    b = VectorList<int>();
51     list<int>         *c = new CircularArray<int>();
52     c->Add(77);
53     DumpList(*c);
54
55     a.Add(4);
56     a.Add(2);
57
58     b.Add(99);
59     b.Add(17);
60
61     DumpList(a);
62     DumpList(b);
63
64     return 0;
65 }

```

1. What is printed to standard output?

- A. 17 99  
2 4  
77
- B. 77  
4 2  
99 17
- C. 4 2  
99 17
- D. 99 17  
4 2  
77
- E. 77  
2 4  
17 99

2. Will this code, if added to the `int main()` method, compile?

```
list<int> someList;
```

- A. Yes, because the compiler will assume the first non-abstract implementation of the `list<T>` class.
- B. Yes, because the `list<T>` class can be directly instantiated, but will throw exceptions when calling the `Length()`, `Add(int)`, or `Get(int)` methods.
- C. No, because there is at least one pure virtual function inside of `list<T>`
- D. No, because `list<T>` does not have a constructor.
- E. No, because `list<T>` has a default constructor, but is not explicitly called in the declaration statement for `someList`.

3. Why are we allowed to pass a `CircularArray<int>` or `VectorList<int>` to the `DumpList` function?

- A. Abstraction
- B. Encapsulation
- C. Type-casting
- D. Polymorphism
- E. We can't, the code does not compile

4. What is the relationship between the `CircularArray` and `VectorList` classes?

- A. `CircularArray` Is-A `VectorList`
- B. `VectorList` Is-A `CircularArray`
- C. `CircularArray` Has-A `VectorList`
- D. `VectorList` Has-A `CircularArray`
- E. None of the above

5. Which of the following will not cause a compile-time exception?

- A. `list<int> *someList = new CircularArray<int>();`
- B. `list<int> someList = new CircularArray<int>();`
- C. `list<int> someList = CircularArray<int>();`
- D. `list<int> &someList = new CircularArray<int>();`
- E. All of the above

Use the `list<T>`, `CircularArray<T>`, and `VectorList<T>` from the previous code, in addition to the following function for questions 6 and 7.

```
1 template <class T>
2 T someFunc(const list<T> &a)
3 {
4     int tmp = a.Get(0);
5     for(int i = 1; i < a.Length(); i++)
6     {
7         tmp = tmp < a.Get(i) ? a.Get(i) : tmp;
8     }
9     return tmp;
10 }
```

6. What is the result of this code:

```
VectorList<int> b = VectorList<int>();
b.Add(99); b.Add(17);
cout << someFunc(b);
```

- A. 17
- B. The code will result in a run-time exception
- C. 2
- D. 4
- E. 99

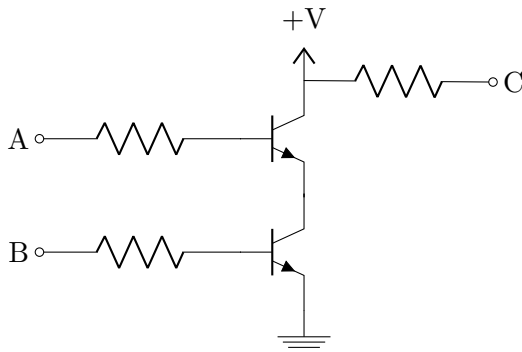
7. Assuming an object of type `CircularArray<T>` is passed to the `someFunc` function, what is the time complexity of `someFunc` expressed in Big-Oh notation?

- A.  $O(1)$
- B.  $O(n)$
- C.  $O(n^2)$
- D.  $O(n \cdot \log n)$
- E.  $O(n!)$

8. Which of the following best describes the Secure Shell (SSH) protocol?

- A. Used to secure HTTP traffic.
- B. A network protocol used to provide secure communications.
- C. The predecessor of telnet.
- D. A network protocol used to send documents to a printer to be printed.
- E. None of the above.

9. Which of the truth tables is logically equivalent to the following circuit?



- | A | B | C |
|---|---|---|
| F | F | T |
| F | T | F |
| T | F | T |
| T | T | F |
- 
- | A | B | C |
|---|---|---|
| F | F | F |
| F | T | F |
| T | F | F |
| T | T | T |

	A	B	C
C.	F	F	F
	F	T	T
	T	F	T
	T	T	F

	A	B	C
D.	F	F	F
	F	T	T
	T	F	T
	T	T	T

	A	B	C
E.	F	F	T
	F	T	T
	T	F	T
	T	T	F

10. What is the result, in decimal, when adding the following Two's Complement binary numbers:  
 $00111011 + 11101111$ .
- A. 76
  - B. -76
  - C. 00101010
  - D. 42
  - E. -42
11. Which of the following is not an example of a secure networking protocol?
- A. HTTPS
  - B. SMTPS
  - C. LDAP
  - D. SSH
  - E. None of the above

Use the following code for questions 12-14.

```

1 void bubbleSort(int a[], int size)
2 {
3     bool changed;
4
5     do {
6         changed = false;
7
8         for(int i = 1; i < size; i++)
9             {
10                if(a[i - 1] > a[i])
11                    {
12                        changed = true;
13                        int tmp = a[i];
14                        a[i] = a[i - 1];
15                        a[i - 1] = tmp;
16                    }
17            }
18    } while(changed);
19 }
```

12. What will the contents of array `a` be with this function call:

```
int a[] = {7, 4, 1, 9};
bubbleSort(a, 6);
```

- A. '\0', 1, 4, 7
- B. 7, 4, 1, 9
- C. 9, 1, 4, 7
- D. 1, 4, 7, 9
- E. Segmentation fault

13. How many times does the conditional on the `while` loop execute?

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

14. Which of the following statements is true regarding the function?

- A. The function sorts an array using a sorting algorithm that is stable
- B. The function sorts an array using a sorting algorithm that is not stable
- C. The function will only produce a sorted array on arrays with an even number of elements
- D. Both A and C
- E. Both B and C



15. What is the largest possible Transmission Control Protocol (TCP) port number?

- A.  $2^4$
- B.  $2^8$
- C.  $2^{16}$
- D.  $2^{24}$
- E.  $2^{32}$

16. What function does Network Address Translation (NAT) perform?

- A. Translates between IPv4 and IPv6 addresses
- B. Translates IP addresses as packets are routed between networks
- C. Translates between MAC addresses and IP addresses
- D. All of the above
- E. None of the above

17. Which of the following is the minimal Sum Of Products notation of the following Karnaugh Map?

	A'B	A'B'	AB'	AB
C'D	T	T	T	F
C'D'	F	T	T	F
CD'	F	T	F	F
CD	T	T	F	F

- A.  $A'B' + B'C' + A'D$
- B.  $A'C'D + A'B' + B'C' + A'CD$
- C.  $C'D + CD + A'B' + AB'C'$
- D.  $A'BD + A'B' + AB'C'$
- E.  $A'B' + B'C' + A'BD$

18. Convert the Octal number 724 to decimal.

- A. F00
- B. 11 0000 0000
- C. 724
- D. 1027
- E. 468

Use the following code for questions 19-22.

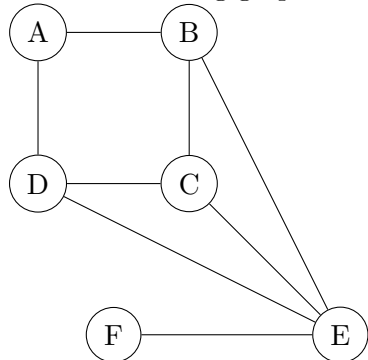
```
1 #include <iostream>
2 using namespace std;
3
4 class Vehicle
5 {
6     private:
7         int wheels;
8     public:
9         Vehicle(int wheelCount = 4)        { setWheels(wheelCount); };
10        void setWheels(int wheelCount);
11        void preferredMovingVerb()    const { cout << "Drive\n"; };
12        bool operator>(Vehicle &rhs) const { return wheels > rhs.wheels; }
13 };
14
15 void Vehicle::setWheels(int wheelCount)
16 {
17     wheels = wheelCount >= 0 ? wheelCount : 0;
18 }
19
20 class Airplane : public Vehicle
21 {
22     public:
23         Airplane() { setWheels(3); };
24         void preferredMovingVerb()    const { cout << "fly\n"; };
25 };
26
27 int main()
28 {
29     Vehicle v; Airplane a;
30
31     v.preferredMovingVerb();
32     a.preferredMovingVerb();
33
34     return 0;
35 }
```

19. What is printed to standard output?

- A. fly  
fly
- B. Drive  
fly
- C. Drive  
Drive
- D. Nothing
- E. None of the above

20. Which of the following best describes how the `preferredMovingVerb()` method in `Airplane` relates to the method of the same name in `Vehicle`?
- A. Overriding
  - B. Inheriting
  - C. Hiding
  - D. Overloading
  - E. Both C and D
21. What is printed to standard output with the following code segment?
- ```
Vehicle a;  
Airplane b;  
(a > b) ? cout << "A has more wheels" : cout << "B has more wheels";
```
- A. A has more wheels
  - B. B has more wheels
  - C. A has more wheelsB has more wheels
  - D. Nothing
  - E. The code does not compile.
22. Which of the following statements is true regarding the `Vehicle` and `Airplane` classes?
- A. Both classes have a default constructor.
  - B. Both classes have a default destructor.
  - C. `Airplane` has a default constructor, but `Vehicle` does not.
  - D. With this statement: `Vehicle v(-1);`, the `wheelCount` for `v` will be set to  $2^{32} - 1$ , assuming `int` is represented with 4 bytes.
  - E. Both A and B are correct.

Use the following graph for questions 23 and 24.



23. Which of the following adjacency matrices matches the graph?

A. 
$$\begin{pmatrix} 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

B. 
$$\begin{pmatrix} 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{pmatrix}$$

C. 
$$\begin{pmatrix} 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

D. 
$$\begin{pmatrix} 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

E. 
$$\begin{pmatrix} 2 & 1 & 0 & 1 & 0 & 0 \\ 1 & 3 & 1 & 0 & 1 & 0 \\ 0 & 1 & 3 & 1 & 1 & 0 \\ 1 & 0 & 1 & 3 & 1 & 0 \\ 0 & 1 & 1 & 1 & 4 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{pmatrix}$$

24. Given a starting point of node B, which of the following traces could represent a breadth-first search?

- A. BACEDF
- B. ACEDFB
- C. BADCEF
- D. BCEADF
- E. Both A and D

Use the following code for question 25.

```
1  int a = 4, b = 2;  
2  cout << (4 << --a - a / b);
```

25. What is printed to standard output?

- A. 31
- B. 42
- C. 16
- D. 14
- E. 14.5

26. How many ternary operators are there in the C++ language?

- A. 0
- B. 1
- C. 7
- D. There can be any number of ternary operators
- E. There is 1 ternary operator, but more can be declared

Use the following code for questions 27-30.

```
1  int fun1(int a)  
2  {  
3      if(a >> 2 == 0)  
4          return a;  
5      else  
6          return fun1(a / 2);  
7  }
```

27. What is the result of the function call `fun1(11);`?

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

28. How many times is `fun1` called in the function call `fun1(11);`?
- A. 0
  - B. 1
  - C. 2
  - D. 3
  - E. 4
29. What is the code on line 3 called?
- A. Base case
  - B. Sanity check assertion
  - C. Function premise
  - D. Conditional case
  - E. None of the above
30. What is the `>>` operator on line 3 called?
- A. Extraction operator
  - B. Insertion operator
  - C. Arrow operator
  - D. Modulus operator
  - E. Shift operator



