# WYSE | ENGINEERING AT ILLINOIS

# 2018 Academic Challenge

## COMPUTER SCIENCE TEST – SECTIONAL

– This Test Consists of 30 Questions –

**Computer Science Test Production Team**
Kevin Schaefer, Independent Consultant – Author & Reviewer
Sahid L. Rosado Lausell, WYSE – Coordinator of Test Production

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** ***

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

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1. Which of the following is true regarding a Turing Test?

    A. A test used to determine if two binary numbers are inverses of each other
    B. A test used to determine whether or not a computer's artificial intelligence is realistic
    C. A test used to determine whether or not a sorting algorithm is stable
    D. A test used to determine whether or not a sorting algorithm is efficient for large lists
    E. A test used to determine if two prime numbers can be used to generate a public key/private key pair

2. An IPv4 address contains how many unique address combinations:

    A. $2^4 = 16$
    B. $2^{32} = 4,294,967,296$
    C. $8^{32} = 7.92 \times 10^{28}$
    D. $10^{32}$
    E. $2^{128} = 3.04 \times 10^{38}$

3. Given binary data is transferred over a fiber optic cable at a speed of 1 Gb/s ($1 \times 10^9$ bps), what distance does a bit travel before the next successive bit is transmitted?

    A. $3.0 \times 10^{-1}$ meters
    B. $1.0 \times 10^9$ meters
    C. $3 \times 10^{17}$ meters
    D. There is not enough information provided to answer
    E. None of the above

4. If the transfer rate between two devices is 100 Mb/s, how long will it take to transmit a 4 MB file, assuming the entire transfer speed of the line can be used?

    A. $100/4 = 25$ s
    B. $4/100 = 0.04$ s
    C. $32/100 = 0.32$ s
    D. $8 \cdot (32/100) = 2.56$ s
    E. $4/1000 = 0.004$ s

5.  Which of the following truth tables represents the following logic symbol:



A.

| x | y | ans |
|---|---|-----|
| F | F | F |
| F | T | F |
| T | F | T |
| T | T | T |

B.

| x | y | ans |
|---|---|-----|
| F | F | F |
| F | T | T |
| T | F | T |
| T | T | T |

C.

| x | y | ans |
|---|---|-----|
| F | F | F |
| F | T | T |
| T | F | T |
| T | T | F |

D.

| x | y | ans |
|---|---|-----|
| F | F | T |
| F | T | F |
| T | F | F |
| T | T | F |

E.

| x | y | ans |
|---|---|-----|
| F | F | T |
| F | T | T |
| T | F | T |
| T | T | F |

6.  Convert 259 from decimal (base-10) to binary (base-2):

   A.  1111 1111 1100
   B.  1111 1111 1101
   C.  0001 0000 0011
   D.  0001 1000 0001
   E.  0x103

7.  Convert 11 1101 0011 from binary to hexadecimal

   A.  102
   B.  979
   C.  F43
   D.  3D3
   E.  None of the above
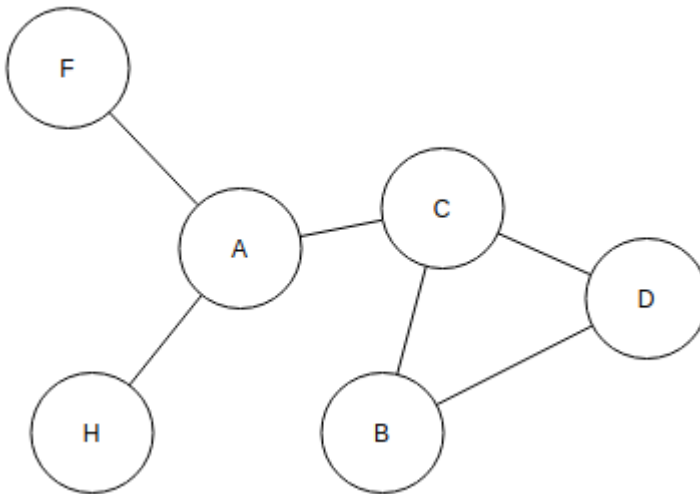
8.  Convert -9 in decimal to binary in two's complement notation

   A.  1111 0111
   B.  0000 1001
   C.  1111 0110
   D.  -0000 1001
   E.  None of the above

9.  A stack data structure can be implemented with which of the following:

   A.  Linked list
   B.  Array
   C.  Doubly linked list
   D.  std::vector
   E.  All of the above

Use the following graph for Questions 10 and 11:



10. Which of the following is a valid breadth-first search of the graph, given that node C is the root node?

    A. CABDFH
    B. CAFHBD
    C. ABDFHC
    D. AFHBDC
    E. FHABDC

11. Which of the following is true regarding max heaps, min heaps, and binary trees?

    A. Both max heaps and min heaps are also binary trees
    B. Max heaps and min heaps are not always, though sometimes are, binary trees
    C. A binary search tree will not be a max heap or a min heap
    D. Max heaps, min heaps, and binary trees can be implemented using arrays
    E. Both A and D are correct

12. Which of the following is true regarding queues and stacks?

    A. Both stacks and queues are first-in-first-out data structures
    B. A stack is a last-in-first-out data structure, while a queue is a first-in-first-out data structure
    C. Both queues and stacks can be implemented using circular arrays
    D. A queue can be first-in-first-out or first-in-last-out, depending on its implementation
    E. Answers B and C are correct

Use the following code for Questions 13, 14, 15, and 16:

```
#include <iostream>
using namespace std;

int main() {
        int a = 92;
        int* b = &a;

        cout << "a = " << a << endl;
        cout << "b = " << b << endl; // Question 14
        cout << "*b = " << *b << endl;
        cout << "**&b = " << **&b << endl; // Question 15
        cout << "sizeof a = " << sizeof(a) << endl; // Question 13
        cout << "sizeof b = " << sizeof(b) << endl; // Question 13

        return 0;
}
```

13. Assuming a computer represents an int with 2 bytes and an address with 4 bytes, what will the code on lines marked with // Question 13 print?

    A. sizeof a = 16
       sizeof b = 32
    B. sizeof a = 16
       sizeof b = 16
    C. sizeof a = 2
       sizeof b = 92
    D. sizeof a = 2
       sizeof b = 4
    E. sizeof a = 2
       sizeof b = 2

14. What will the code on the line marked with // Question 14 print?
    A. The address that variable b is stored at, which will be determined at run-time
    B. The address that variable a is stored at, which will be determined at compile-time
    C. The address that variable a is stored at, which will be determined at run-time
    D. "&a"
    E. This line will not compile

15. What will the code on the line marked with // Question 15 print?
    A. 92
    B. NULL
    C. The address that variable b is stored at, which will be determined at run-time
    D. The address that variable b is stored at, which will be determined at compile-time
    E. This line will not compile

16. What line of code would change the value of a to 19?

    A. `&b = 19`
    B. `*b = 19`
    C. `b->19`
    D. `&a = 19`
    E. `*a = 19`

*This space intentionally left blank*

Use this code for Questions 17, 18, 19, and 20:

```
class Vehicle {
   private:
        int vehicleIndex;
   public:
        Vehicle(int vehicleIndex);
        ~Vehicle()                      { };

        int GetVehicleIndex() const { return vehicleIndex; };
};

Vehicle::Vehicle(int vehicleIndex) {
   this->vehicleIndex = vehicleIndex;
}

class Car : protected Vehicle {
   public:
        Car()                           : Car(-1) { };
        Car(int vehicleIndex)           : Vehicle(vehicleIndex) { };
        ~Car()                          { };

        bool operator>(const Car &rhs); // Question 18
        Car  operator+(const Car &rhs);
        friend ostream & operator << (ostream &out, const Car &rhs);
        int GetCarIndex() const { return GetVehicleIndex(); };

};

bool Car::operator>(const Car &rhs) {
   return this->GetVehicleIndex() > rhs.GetVehicleIndex();
}

Car Car::operator+(const Car &rhs) {
   Car tmp(this->GetVehicleIndex() + rhs.GetVehicleIndex());
   return tmp;
}

ostream & operator << (ostream &out, const Car &rhs) {
   out << "I'm car " << rhs.GetVehicleIndex();
   return out;
}

// continued on next page
```

```
int main()
{
    Car cars[2] = { Car(0), Car() };

    cout << cars[0].GetCarIndex() << endl;
    cout << (cars[2] > cars[0]) << endl;
    cout << (cars[0]) << endl;
    return 0;
}
```

17. What is the best description of the relationship between `Car` and `Vehicle` classes?

    A. Vehicle is-a Car
    B. Vehicle has-a Car
    C. Car has-a Vehicle
    D. Car is-a Vehicle
    E. Car and Vehicle are not related

18. What is the best way to describe the variable `rhs` on the line marked with `// Question 18` above?

    A. A pointer to an instance of `Car`
    B. A pass-by-reference parameter
    C. A compile-time constant
    D. Both A and B are correct
    E. None of the above

19. In which order will the `Vehicle` and `Car` constructors and destructors be called?

    A. Constructors: Vehicle 0, Car 0, Vehicle -1, Car -1
       Destructors: Car -1, Vehicle -1, Car 0, Vehicle 0
    B. Constructors: Car 0, Vehicle 0, Car -1, Vehicle -1
       Destructors: Car 0, Vehicle 0, Car -1, Vehicle -1
    C. Constructors: Vehicle 0, Car 0, Vehicle -1, Car -1
       Destructors: Vehicle 0, Car 0, Vehicle -1, Car -1
    D. Constructors: Car 0, Vehicle 0, Car -1, Vehicle -1
       Destructors: Vehicle -1, Car -1, Vehicle 0, Car 0
    E. None of the above

20. What line of code, if added within `int main`, would not result in a compile-time error?

    A. `cars[0].vehicleIndex++;`
    B. `cars[1]->GetCarIndex();`
    C. `cars[-1]->GetCarIndex();`
    D. `cars[1].GetCarIndex();`
    E. All of these will result in a compile-time error

Use this code for Questions 21, 22, and 23:

```
int funB(int a)
{
   int b = 0; // Question 22

   do {
        b += a;
   } while(a--); // Question 23

   return b;
}

int main()
{
   cout << funB(5);
   cout << funB(0x3);
   return 0;
}
```

21. What will be printed to stdout?

       A. 145
       B. 00
       C. 156
       D. The code will not compile
       E. None of the above

22. If the variable declaration on the line marked with `// Question 22` was changed to `static`, what would be the output?

       A. 1419
       B. 156
       C. 00
       D. 1521
       E. The code will not compile

23. What is the operator called on the line marked with `// Question 23`?

       A. Postfix decrement
       B. Prefix decrement
       C. Do-while conditional
       D. Decrement
       E. None of the above

Use this code for Questions 24 and 25:

```
static char FACES[14] = "A234567890KQJ";
static char SUITS[5 ] = "CHSD";

int i;
cin >> i;

char face = FACES[i];
char suit = SUITS[i % 4];

if(face == '0') cout << "10";
else cout << face;
cout << " ";

switch(suit)
{
        case 'C':
                cout << "Clubs";
        case 'H':
                cout << "Hearts";
        case 'S':
                cout << "Spades";
        case 'D':
                cout << "Diamonds";
}
```

24. If the user enters 5, what will be printed to the screen?

      A. 6 Hearts
      B. 5 Hearts
      C. 6 Clubs
      D. 5 Clubs
      E. None of the above

25. Which of the following is true with regards to the SUITS array?

      A. SUITS[4] = 'D'
      B. Without causing any compile-time errors, it could be declared as static char
          SUITS[4] = "CHSD";
      C. SUITS[4] = '\0';
      D. Without causing any compile-time errors, it could be declared as static char
          SUITS[4] = {'C', 'H', 'S', 'D'};
      E. Both C and D are correct

Use this code for Questions 26, 27, 28, 29, and 30:

```
template <class T>
class enumerable
{
        public:
                virtual T pop() = 0;
                virtual bool empty() = 0;
};

class class1 : public enumerable<int>
{
        private:
                int a[10] = { 0 };
                int i;
                int j;
        public:
                class1() { i = 0; j = 0; }
                void push(int x);
                int pop();
                int peek();
                bool empty() { return i == j; }
};

void class1::push(int x)
{
        a[j++] = x;
        if(j >= 10) j = 0;
}

int class1::pop()
{
        int y = a[i++];
        if(i >= 10) i = 0;
        return y;
}

int class1::peek()
{
        return a[i];
}

// continued on next page
```

```
template <class T>
void PrintEnumerable(enumerable<T> *a)
{
        while(a->empty() == false)
                cout << a->pop() << " ";
}

int main()
{
        class1 q;

        q.push(2);
        q.push(4);
        q.pop();
        q.push(6);
        q.push(8);
        q.push(10);
        q.push(12);

        int a = q.peek();
        int b = q.pop();
        q.push(q.pop());

        int c = q.pop();
        cout << a << " " << b << " " << c << endl;

        // PrintEnumerable(&q); // Question 29
        return 0;
}
```

26. What will be printed to the screen?

        A.  6 6 8
        B.  2 4 6
        C.  4 4 8
        D.  2 6 8
        E.  12 12 10


27. Which of the following best describes the code?

        A.  The code is implementing a last-in-first-out (LIFO) data structure
        B.  The code is implementing a first-in-first-out (FIFO) data structure
        C.  The code uses a circular array to implement a stack
        D.  Both A and C are correct
        E.  None of the above are correct

28. What values do `class1`'s private variables `i` and `j` contain after the code executes?

    A.  i: 0, j: 3
    B.  i: 0, j: 7
    C.  i: 3, j: 7
    D.  i: 4, j: 3
    E.  i: 4, j: 7


29. If the code marked with `// Question 29` was uncommented, what would the `PrintEnumerable` function print to the screen?

    A.  10 12 6
    B.  10 12
    C.  2 6 8
    D.  6 12 10
    E.  8 6 2


30. What is the `PrintEnumerable` function making use of?

    A.  Linked Lists
    B.  Encapsulation
    C.  Polymorphism
    D.  Abstraction
    E.  All of the above