



2020 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
2020 Sectional Computer Science Exam

1. Convert the following expression, which uses prefix notation, to infix notation: $x - 5 \ 3 \ 1$
 - A. $5 \times (3 - 1)$
 - B. $5 \times 3 - 1$
 - C. $5 - (3 \times 1)$
 - D. $5 - 3 \times 1$
 - E. $(5 - 3) \times 1$

2. Which of the following best describes network peering?
 - A. A man-in-the-middle attack
 - B. A network connection between two separate Internet Service Providers
 - C. Intrusion detection and prevention
 - D. Ethernet flow control
 - E. Internet service for a residential customer

Use the following Adjacency Matrix for questions 3 and 4:

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

3. What would be the shortest path from node 1 to node 3?
 - A. $1 > 4 > 3$
 - B. $1 > 4 > 2 > 3$
 - C. $1 > 3$
 - D. $1 > 2 > 3$
 - E. There is no path between nodes 1 and 2

4. Assume an undirected edge is added between nodes 3 and 4. What does the row in the Adjacency Matrix look like for node 3?
 - A. $\{ 0, 1, 0, 1, 0 \}$
 - B. $\{ 0, 1, 0, 0, 0 \}$
 - C. $\{ 0, 1, 1, 1, 0 \}$
 - D. $\{ 0, 1, 2, 1, 0 \}$
 - E. $\{ 0, 1, 0, 1, 1 \}$

5. What is the average time complexity expressed in Big-Oh Notation for a binary search?
- A. $O(n)$
 - B. $O(n/2)$
 - C. $O(n!)$
 - D. $O(\log(n))$
 - E. $O(n \cdot \log(n))$
6. Which of the following statements is true regarding a Parity bit?
- A. The last bit of a TCP message envelope
 - B. A bit used to indicate whether there should be an even or odd number of 1's for a certain set of bits
 - C. A method of correcting up to one error when transmitting bits over a network
 - D. A bit used to mark the boot disk for a computer
 - E. A bit used to gauge the signal strength of a wireless connection that allows a receiving station to measure the amplitude of the bit and compare it against a known amplitude.
7. A SHA-1 hash code is composed of a 160-bit message. What is the probability that when taking the SHA-1 hash of some value, the resulting hash in binary starts with 20 zeros?
- A. $1/(2^{160})$
 - B. $2 \cdot 160$
 - C. $1/(2^{20})$
 - D. $1/(2^{20-1})$
 - E. $20 \cdot 2$

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8. A microcontroller executes the following code to transmit a message to a digital display:

```
1  const int CLOCK = 15;
2  const int DATA = 16;
3  const int LOW = 0;
4  const int HIGH = 1;
5  void transmit(char a)
6  {
7      for(int i = 0; i < 8; i++)
8      {
9          digitalWrite(CLOCK, LOW);
10         digitalWrite(DATA, (a >> i) & 0x01);
11         digitalWrite(CLOCK, HIGH);
12         sleep(10);
13     }
14 }
```

Also assume that the function `sleep` is used to pause execution for the specified number of milliseconds, and `digitalWrite` is used to set the specified output pin to the specified digital value (i.e., bit value). What is the purpose of the `>>` and `&` on the second call to `digitalWrite`?

- A. Right-shifts the value and flushes the output stream
 - B. Right-shifts the value and does a bitwise AND to get the i^{th} bit
 - C. The code does not compile
 - D. Selects the i^{th} bit, starting from the most-significant bit
 - E. Inserts the character into the output stream
9. Using the code from question 8, what data will be sent on output pin DATA if the function `transmit` is called with `0x61` (which is the character 'a')?
- A. 0110 0001
 - B. 1010 1010
 - C. 0101 0101
 - D. 1000 0110
 - E. 0x01
10. A binary search is used to find an element in a sorted array containing n elements. How many comparisons are needed to find an element in the best case?
- A. 0
 - B. n
 - C. $n - 1$
 - D. 1
 - E. There is not enough information provided

11. Assume a simplified assembly language uses the following instruction set:

Symbolic representation	Description
LOAD A(x)	Load the value at memory location x into register A
STOR A(x)	Copy the value from register A into memory location x
LOAD B(x)	Load the value at memory location x into register B
STOR B(x)	Copy the value from register B into memory location x
ADDM A(x)	Add the value at memory location x to register A
JMPP B(y)	Jump to program step y if the value of register B is greater than zero
INCR B	Increment the value stored in register B by 1
DECR B	Decrement the value stored in register B by 1
STRL (x,d)	Store the literal value d to memory location x
NOOP	Don't do anything, and move to the next instruction

What is the following code doing?

0x01 STRL (0x20, 0x00)

0x02 STRL (0x21, 0x05)

0x03 STRL (0x22, 0x02)

0x04 LOAD A(0x20)

0x05 LOAD B(0x21)

0x06 ADDM A(0x22)

0x07 DECR B

0x08 JMPP B(0x6)

0x09 STOR A(0x23)

- A. An infinite loop occurs
- B. The sum of the integers 0 through 5 is calculated
- C. The value 2 is added up 5 times
- D. The value 0x02 is copied into a register, then written back to memory
- E. The least common divisor of 0x02 and 0x05 is calculated

12. After the code executes, what is stored in memory location 0x23?

- A. 10
- B. 20
- C. 6
- D. 0
- E. NULL

13. If the instruction at memory location 0x08 were changed to NOOP, what would be stored in memory location 0x23?
- A. 0
 - B. 2
 - C. 20
 - D. 1
 - E. *Infinite loop*

Use the following code for questions 14 through 16:

```
1 #include <iostream>
2 using namespace std;
3
4 int main()
5 {
6     int a = 10;
7     int b = 0;
8
9     do {
10        b += a;
11    } while(--a % 7 && b);
12
13    cout << b << a << endl;
14    return 0;
15 }
```

14. What will be printed to standard output?
- A. 277
 - B. 727
 - C. 010
 - D. 346
 - E. 198
15. What is the `&&` in the `while` conditional?
- A. Bitwise AND operator
 - B. Logical AND operator
 - C. Postfix increment operator
 - D. Prefix increment operator
 - E. Logical pointer dereferencing operator

16. How many times does the `while` conditional execute?
- A. 70
 - B. 10
 - C. 3
 - D. Infinite
 - E. 11
17. A template function is an example of which of the following?
- A. Inheritance
 - B. Friend method
 - C. Operator overloading
 - D. Overloadable method
 - E. Polymorphism

Use the following code for questions 18 through 20:

```
1 #include <iostream>
2 using namespace std;
3
4 #define CHECK(x,y) (x % y)
5
6 int main()
7 {
8     int a = 4;
9     int b = 3;
10
11 #ifdef a
12     a += b;
13 #endif
14
15     for (int i = 0; i < CHECK(a, b); i++)
16     {
17         cout << b << endl;
18     }
19
20     return 0;
21 }
```

18. What is `CHECK`?
- A. Preprocessor directive
 - B. Predefined function
 - C. Constant function
 - D. Macro
 - E. Both A and D

19. How many times does the `cout` statement get executed?
- A. 0
 - B. 1
 - C. 3
 - D. 4
 - E. 5
20. If `#define a 1` were added immediately before `int main`, how many times would the `cout` statement be executed?
- A. 1
 - B. 7
 - C. *The code does not compile*
 - D. *Infinite loop*
 - E. 3
21. A best-practice when implementing a modern RESTful Web API is to utilize HTTPS. Which of the following explains the benefits of this?
- A. HTTPS increases the speed of accessing web services
 - B. HTTPS provides a method of preventing data-tampering at-rest
 - C. HTTPS provides a method of preventing data-tampering in-transit
 - D. Both A and C
 - E. Both A and B
22. Which of the following is an example of a TLD (top-level domain)?
- A. example
 - B. example.com
 - C. example.com. 3600 IN MX 10 mx01.example.com.
 - D. edu
 - E. . (dot)
23. What is logically equivalent to the following expression if `Z` is `true`?
- $$(X \wedge \neg Y \wedge \neg Z) \vee (Y \wedge Z) \vee (Z \wedge \neg Z)$$
- A. $(X \wedge \neg Y) \vee Y \vee \text{true}$
 - B. $Y \vee \text{false}$
 - C. Y
 - D. `true`
 - E. Both B and C

24. A given algorithm takes $2 \cdot x^2 + x + 4 + 6 \cdot x^2$ steps to complete. The time it takes for this algorithm to complete can be rewritten as which of the following?
- A. $\theta(x)$
 - B. $O(x^2)$
 - C. $\theta(8x^2)$
 - D. $\theta(x^2)$
 - E. Both B and D
25. A shift register is an electrical component that contains n flip-flop circuits, which can store n bits. A serial-in parallel-out shift register has 1 data input line, 1 clock input line, and n output lines. As the clock signal pulses, the bit stored in each flip-flop is advanced to the next flip-flop, and the bit on the data input line is stored in the first flip-flop. If the hexadecimal value 0x5A is shifted (with the most-significant bit first) into an 8-bit serial-in parallel-out shift register, what is the binary data in output pin 5 of the shift register? Assume the output pins are numbered 0...7, with pin 7 being the output of the first flip-flop in the series.
- A. 0
 - B. 1
 - C. 0x5
 - D. 0xA
 - E. Indeterminate

Exam continues on next page

Use the following code for questions 26 through 29:

```
1 #include <iostream>
2 using namespace std;
3
4 int i;
5 void fun(unsigned int a)
6 {
7     for(i = 0; i < a; i++)
8     {
9         for(int j = i; j < --a; j++)
10        {
11            cout << "Hi ";
12        }
13    }
14    cout << endl;
15 }
16
17 int main()
18 {
19     fun(3);
20
21     return 0;
22 }
```

26. What is printed to standard output?

- A. *Nothing*
- B. The word "Hi" printed 6 times
- C. The word "Hi" printed 3 times
- D. The word "Hi" printed 1 time
- E. *Infinite loop or does not compile*

27. What scope is variable i defined in?

- A. Global Address Scope
- B. Function Scope
- C. Global Scope
- D. On the stack
- E. On the heap

28. If the call `fun(3)` were changed to `fun(-3)`, what would happen?
- A. Compile-time exception, since `-3` cannot be assigned to an `unsigned int` parameter
 - B. Compile-time exception, since `-3` would cause an infinite loop
 - C. Runtime exception, since `-3` cannot be assigned to an `unsigned int` parameter
 - D. The output of the program would remain unchanged, since `-3` would be type-casted from an `int` to an `unsigned int`, resulting in `a` being set to `3`
 - E. None of the above
29. How many times is `a` decremented in function `fun`?
- A. 0
 - B. 1
 - C. 2
 - D. 3
 - E. 4
30. Assume a class, `Box`, is declared. Which of the following correctly implements the overloaded stream insertion operator?
- A.

```
ostream& operator<<(ostream& os, const Box& b)
{
    os << "(" << b.getWidth() << ", " << b.getHeight() << ")";
    return os;
}
```
 - B.

```
istream& operator>>(istream& is, const Box& b)
{
    is >> b.width >> b.height;
    return is;
}
```
 - C.

```
ostream& operator<<(const ostream& os, const Box& b)
{
    os << "(" << b.getWidth() << ", " << b.getHeight() << ")";
    return os;
}
```
 - D.

```
ostream& operator<<(const Box& b, const ostream& os)
{
    os << "(" << b.getWidth() << ", " << b.getHeight() << ")";
    return os;
}
```
 - E.

```
ostream& operator<<(ostream& os)
{
    os << "(" << this.getWidth() << ", " << this.getHeight() << ")";
    return os;
}
```

