American Computer Science League

2019-2020 **ACSL Finals**

Junior Shorts

1. Boolean Algebra

Simplify the following Boolean expression to use AND, OR, and NOT operators with no parentheses. How many OR operators are there?

$$\overline{A\,\overline{B} + C} \cdot A \cdot B \cdot \overline{\overline{B} + C}$$

A. 0
B. 1
C. 2
D. 3
E. None of the above

2. Boolean Algebra

Define a new binary operator, $, as follows:

$$A \$ B = \overline{A}\,B + \overline{B}$$

It has higher precedence than the AND operator.

How many ordered pairs make the following TRUE?

$$A \$ B + (\overline{A} + B)(\overline{A} \$ \overline{B})$$

A. 0
B. 2
C. 3
D. 4
E. None of the above

3. Bit-String Flicking

Evaluate this expression:

```
(RSHIFT-2 (LCIRC-1 (NOT 0111001))) AND
(NOT (RCIRC-2 (LSHIFT-1 1100011)))
```

A. 1111101
B. 0101110
C. 0000010
D. 0000011
E. None of the above

4. Bit-String Flicking

How many different values of x (a bitstring of 5 bits) make the following equation true?

```
(LCIRC-2 01010) OR (RSHIFT-1 ((LCIRC-2 X) AND
                 01110))= 01101
```

A. 0
B. 4
C. 8
D. 10
E. None of the above

5. Recursive Functions

Find f (17) given:

$$f(x) = \begin{cases} 2 \cdot f(x-3) + 4 & if \ x \geq 4 \\ 3x + 2 & if \ x < 4 \end{cases}$$

A. 8
B. 28
C. 124
D. 380
E. None of the above

6. Recursive Functions

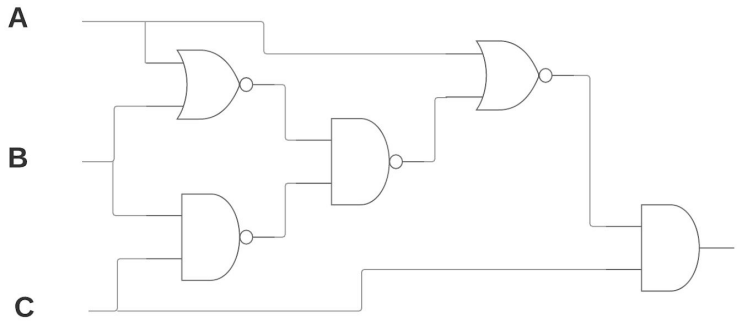
Find f (25) given the function below if [x] is the greatest integer less than or equal to x:

$$f(x) = \begin{cases} 2 + f\left(\left[\frac{x}{2}\right]\right) & if \ x \geq 7 \\ f(x-1) + f(x-2) & if \ 3 < x < 7 \\ x^2 + 1 & if \ x \leq 3 \end{cases}$$

A. 25
B. 40
C. 44
D. 48
E. None of the above

7. Digital Electronics

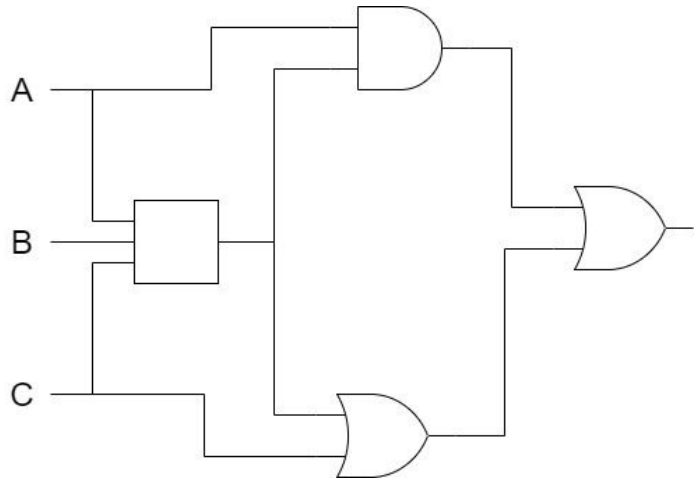
Find all ordered triples that make the following circuit TRUE. Your answer will be a single 3-character string in the format XYZ where each X Y Z is either 0, 1, or * (e.g. 0*1, 110, **0).



A. *01
B. 100
C. 0*0
D. 001
E. None of the above

8. Digital Electronics

Define a new gate , ☐ , with 3 inputs. It is TRUE if there is exactly one TRUE input. How many ordered triples make the following digital circuit TRUE?



A. 0
B. 2
C. 4
D. 6
E. None of the above

9. Prefix-Infix-Postfix

Define: a $ b = minimum of {a,b}
a% = absolute value of a

Evaluate this prefix expression if all numbers are single digits:

- % - + 2 ^ 3 2 4 * + / 8 4 $ 2 0 / / + 8 2 $ 2 5 % - 3 8

A. 3
B. 5
C. 7
D. 9
E. None of the above

10. Prefix-Infix-Postfix

Evaluate the following postfix expression if A = 5, B = 3, and C = 2:

A B C + / B C ^ ^ B A + C B ^ / A * +

A. 6
B. 5
C. 1
D. -4
E. None of the above

11. Computer Number Systems

Evaluate and express the result in hexadecimal:

$$2020_8 - 202_8 - 20_8 + 2_8$$

A. 700
B. 1F0
C. 380
D. 160
E. None of the above

12. Computer Number Systems

How many 1's are there in the binary representations of the decimal numbers 50 to 64 inclusive?

A. 56
B. 60
C. 62
D. 70
E. None of the above

13. Data Structures

What would be the next item popped given the following initially empty stack?

PUSH(G), PUSH(E), PUSH(R), PUSH(B), POP(X), POP(X), PUSH(E), POP(X), PUSH(R), PUSH(A), PUSH(D), POP(X), PUSH(A), PUSH(I), POP(X), POP(X), PUSH(S), PUSH(Y), POP(X), POP(X), POP(X)

A. A
B. B
C. G
D. R
E. None of the above

14. Data Structures

What is the depth of the binary search tree for:

SOCIALDISTANCING

A. 4
B. 5
C. 6
D. 7
E. None of the above

15. Graph Theory

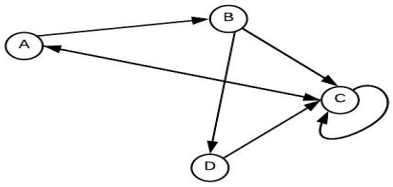
How many cycles are there in the graph represented by the given adjacency matrix?

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

A. 7
B. 6
C. 5
D. 4
E. None of the above

16. Graph Theory

How many total paths of length 2 are in the following graph?



A. 10
B. 11
C. 12
D. 13
E. None of the above

17. What Does This Program Do?

What will be printed when this program is executed?

```
Y = 2020
S = 0 : N = 0 : F = 0
for A = 1 to Y
   if INT(Y / A) == Y / A then
       S = S + A
       N = N + 1
   end if
   if S > Y and F = 0 then
      output N - 1
      F = 1
   end if
next
```

A. 8
B. 9
C. 10
D. 11
E. None of the above

18. What Does This Program Do?

What will be printed when this program is executed? Remember A[0] = "C".

```
A = "CORONAVIRUS" : B = "COVID-19" : S = 0
for X = 0 to len(A) - 1
    for Y = 0 TO len(B) - 1
        if A[X] == B[Y] then
            S = S + X * Y
        end if
    next
next
output S
```

A. 16
B. 37
C. 40
D. 66
E. None of the above

19. What Does This Program Do?

What would be outputted when this program is executed on this predefined array of values (A)? Remember A(0) = 42.

42	19	71	21	28	69	33	57	11

```
S = 0 : N = 9
for X = 0 to N - 1
    S = S + A(X)
next
V = S / N
for X = 0 to N - 1
     if X < N / 2 and A(X) < V then
         C = C + 1
    else
        if X > N / 2 and A(X) > V then
            C = C + 1
        end if
    end if
next
output C
```

A. 0
B. 4
C. 5
D. 6
E, None of the above

20. What Does This Program Do?

What would be outputted when this program is executed given the following values of array A? Remember A(0,0) = 0.

Given the input values 4, 8, 11, 2, 5, 14, 6, what is the output?

0	3	2	4	1
4	5	1	3	2
1	2	4	5	1

```
S = 0
for N = 1 to 7
    input V
    R = int(V / 5)
    C = V % 5
    S = S + A(R,C)
next
output S
```

A. 18
B. 19
C. 21
D. 50
E. None of the above

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1. Boolean Algebra

使用不带括号的AND,OR和NOT运算符来化简下述的布尔表达式。请问化简后的布尔表达式中有多少个OR运算符?

$$\overline{A\,\overline{B}\,+\,C}\cdot A\cdot B\cdot \overline{\overline{B}\,+\,C}$$

A. 0
B. 1
C. 2
D. 3
E. 以上均不是正确答案

---

2. Boolean Algebra

定义一个新的二进制运算符, $, 如下所示:

$$A\,\$\,B\;=\;\overline{A}\,B\,+\,\overline{B}$$

它的优先级高于 AND 运算符。
请问有多少个有序对能使下式为真?

$$A\,\$\,B\,+\,(\overline{A}\,+\,B)\,(\overline{A}\;\$\;\overline{B})$$

A. 0
B. 2
C. 3
D. 4
E. 以上均不是正确答案

---

3. Bit-String Flicking

计算这个表达式:

```
(RSHIFT-2 (LCIRC-1 (NOT 0111001))) AND
(NOT (RCIRC-2 (LSHIFT-1 1100011)))
```

A. 1111101
B. 0101110
C. 0000010
D. 0000011
E. 以上均不是正确答案

---

4. Bit-String Flicking

有多少个不同的x值（一个字符串长度为5个字节）能够使得下列表达式为真?

```
(LCIRC-2 01010) OR (RSHIFT-1 ((LCIRC-2 X) AND
                 01110))= 01101
```

A. 0
B. 4
C. 8
D. 10
E. 以上均不是正确答案

5. Recursive Functions

计算 $f(17)$：

$$f(x)=\begin{cases}2\cdot f(x-3)+4 & if\ x\geq 4\\ 3x+2 & if\ x<4\end{cases}$$

A. 8
B. 28
C. 124
D. 380
E. 以上均不是正确答案

6. Recursive Functions

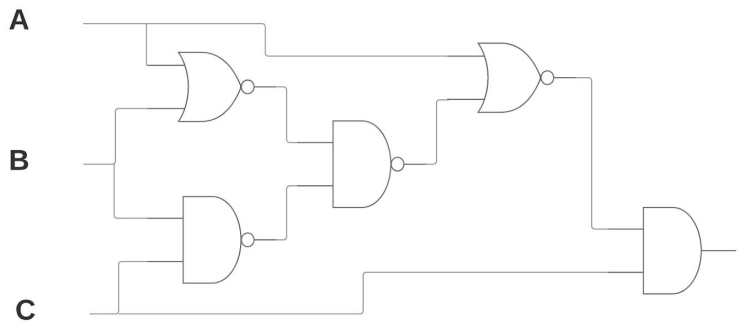
根据以下函数求出$f(25)$，如果[x]是一个小于或等于x的最大整数：

$$f(x)=\begin{cases}2+f\left(\left[\frac{x}{2}\right]\right) & if\ x\geq 7\\ f(x-1)+f(x-2) & if\ 3<x<7\\ x^2+1 & if\ x\leq 3\end{cases}$$

A. 25
B. 40
C. 44
D. 48
E. 以上均不是正确答案

7. Digital Electronics

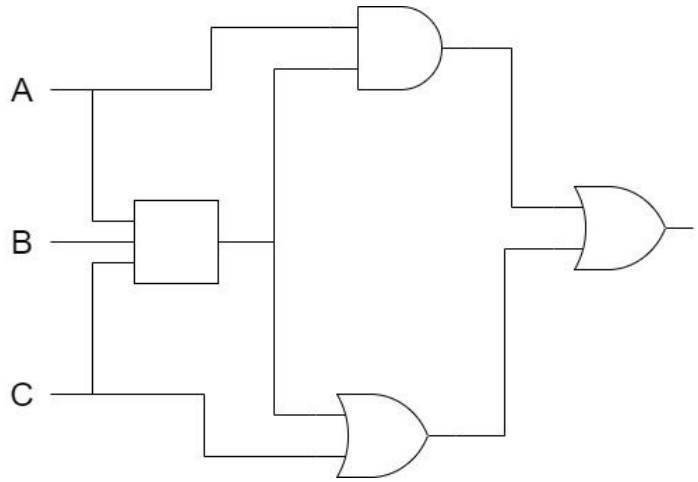
求出能够使得如下电路为真的所有的有序三元组。你的回答格式为XYZ这类3个字符的字符串，在字符串XYZ中，每个字符X、Y、Z的值要么是0要么是1，或者是*。(e.g. 0*1, 110, **0).



A. *01
B. 100
C. 0*0
D. 001
E. 以上均不是正确答案

8. Digital Electronics

定义一个新门, □ , 有3个输入值。如果只有一个输入使得电路为真，那么这个输入就是正确的。请问有多少有序三元组可以使以下数字电路为真?



A. 0
B. 2
C. 4
D. 6
E. 以上均不是正确答案

9. Prefix-Infix-Postfix

定义: a $ b = {a,b}的最小值
a% = a 的绝对值

若所有的数字都是单独的数字，请计算下述前缀表达式的值:

- % - + 2 ^ 3 2 4 * + / 8 4 $ 2 0 / / + 8 2 $ 2 5 % - 3 8

A. 3
B. 5
C. 7
D. 9
E. 以上均不是正确答案

10. Prefix-Infix-Postfix

若A = 5, B = 3, C = 2，请计算下列后缀表达式的值:

A B C + / B C ^ ^ B A + C B ^ / A * +

A. 6
B. 5
C. 1
D. -4
E. 以上均不是正确答案

11. Computer Number Systems

计算下面式子的值，并以十六进制表示结果：

$$2020_8 - 202_8 - 20_8 + 2_8$$

A. 700
B. 1F0
C. 380
D. 160
E. 以上均不是正确答案

12. Computer Number Systems

在50到64（包括50和64）的十进制数在二进制表示下一共有多少个1?

A. 56
B. 60
C. 62
D. 70
E. 以上均不是正确答案

13. Data Structures

给定一个初始为空的堆栈，请问执行完所有指令后，下一个弹出项是什么?

PUSH(G), PUSH(E), PUSH(R), PUSH(B), POP(X), POP(X), PUSH(E), POP(X), PUSH(R), PUSH(A), PUSH(D), POP(X), PUSH(A), PUSH(I), POP(X), POP(X), PUSH(S), PUSH(Y), POP(X), POP(X), POP(X)

A. A
B. B
C. G
D. R
E. 以上均不是正确答案

14. Data Structures

请问二叉搜索树的深度是多少?

SOCIALDISTANCING

A. 4
B. 5
C. 6
D. 7
E. 以上均不是正确答案

15. Graph Theory

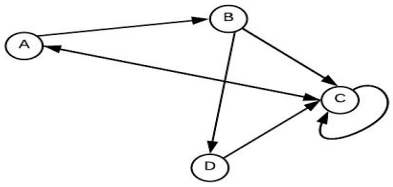
在给定的邻接矩阵表示的图中有多少个环?

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

A. 7
B. 6
C. 5
D. 4
E. 以上均不是正确答案

16. Graph Theory

下图中有多少条总长度为2的路径?



A. 10
B. 11
C. 12
D. 13
E. 以上均不是正确答案

17. What Does This Program Do?

执行以下程序后会打印输出什么?

```
Y = 2020
S = 0 : N = 0 : F = 0
for A = 1 to Y
   if INT(Y / A) == Y / A then
       S = S + A
       N = N + 1
   end if
   if S > Y and F = 0 then
      output N - 1
      F = 1
   end if
next
```

A. 8
B. 9
C. 10
D. 11
E. 以上均不是正确答案

18. What Does This Program Do?

执行这个程序会输出什么？已知A[0] = “C”。

```
A = "CORONAVIRUS" : B = "COVID-19" : S = 0
for X = 0 to len(A) - 1
    for Y = 0 TO len(B) - 1
        if A[X] == B[Y] then
            S = S + X * Y
        end if
    next
next
output S
```

A. 16
B. 37
C. 40
D. 66
E. 以上均不是正确答案

19. What Does This Program Do?

如下方格中预定义数组A的值，当此程序被执行后将会输出什么？已知A（0）=42

42	19	71	21	28	69	33	57	11

```
S = 0 : N = 9
for X = 0 to N - 1
    S = S + A(X)
next
V = S / N
for X = 0 to N - 1
     if X < N / 2 and A(X) < V then
         C = C + 1
    else
        if X > N / 2 and A(X) > V then
            C = C + 1
        end if
    end if
next
output C
```

A. 0
B. 4
C. 5
D. 6
E. 以上均不是正确答案

20. What Does This Program Do?

给定下列数组A的值，执行这个程序后，请问输出值是多少?
已知A(0,0) = 0.

给定输入值 4, 8, 11, 2, 5, 14, 6, 请问输出值是多少?

0	3	2	4	1
4	5	1	3	2
1	2	4	5	1

```
S = 0
for N = 1 to 7
    input V
    R = int(V / 5)
    C = V % 5
    S = S + A(R,C)
next
output S
```

A. 18
B. 19
C. 21
D. 50
E. 以上均不是正确答案