

2019-2020

American Computer Science League

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:

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

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

6. Recursive Functions

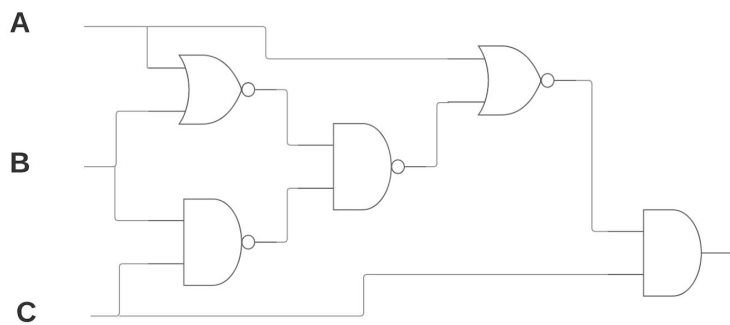
Find $f(25)$ given the function below if $[x]$ is the greatest integer less than or equal to x :

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

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


7. Digital Electronics

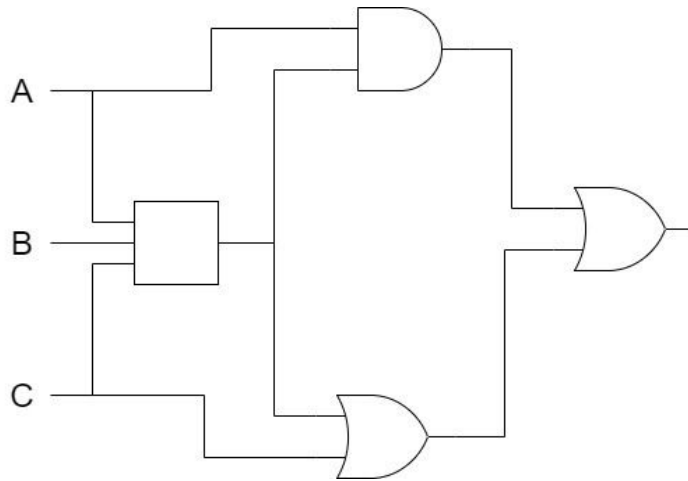
Find all ordered triples that make the following circuit TRUE. Your answer will be a single 3-character string in the format XYZ where each X Y Z is either 0, 1, or * (e.g. 0*1, 110, **0).



- 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: $a \$ b = \text{minimum of } \{a, b\}$
 $a\% = \text{absolute value of } a$

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 $C = 2$:

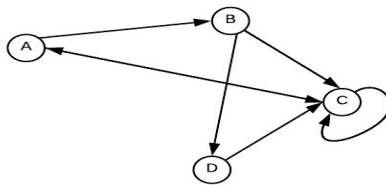
$A B C + / B C ^ ^ B A + C B ^ / A * +$

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

<p>11. Computer Number Systems</p> <p>Evaluate and express the result in hexadecimal:</p> $2020_8 - 202_8 - 20_8 + 2_8$	<p>A. 700 B. 1F0 C. 380 D. 160 E. None of the above</p>
<p>12. Computer Number Systems</p> <p>How many 1's are there in the binary representations of the decimal numbers 50 to 64 inclusive?</p>	<p>A. 56 B. 60 C. 62 D. 70 E. None of the above</p>
<p>13. Data Structures</p> <p>What would be the next item popped given the following initially empty stack?</p> <p>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)</p>	<p>A. A B. B C. G D. R E. None of the above</p>
<p>14. Data Structures</p> <p>What is the depth of the binary search tree for:</p> <p style="text-align: center;">SOCIALDISTANCING</p>	<p>A. 4 B. 5 C. 6 D. 7 E. None of the above</p>
<p>15. Graph Theory</p> <p>How many cycles are there in the graph represented by the given adjacency matrix?</p> $\begin{bmatrix} 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix}$	<p>A. 7 B. 6 C. 5 D. 4 E. None of the above</p>

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