American Computer Science League

2018-2019 **All-Star Contest**

Junior Division
Short Round Solutions

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1. Boolean Algebra

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

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

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

$= (\overline{\overline{A}}\overline{\overline{B}}C+0)(A+\overline{\overline{B}}\overline{\overline{C}}) = \overline{\overline{A}}\overline{\overline{B}}C(A+\overline{\overline{B}}\overline{\overline{C}})$

$= \overline{\overline{A}}\overline{\overline{B}}CA+\overline{\overline{A}}\overline{\overline{B}}C\overline{\overline{B}}\overline{\overline{C}} = 0+0=0$

Since the expression is always FALSE, there are no ordered triples that make it TRUE.

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

A. 0

2. Bit-String Flicking

x = 110101

(LSHIFT-1 x) OR (RCIRC-2 x) AND (RSHIFT-3 x)

= (LSHIFT-1 110101) OR (RCIRC-2 110101)
AND (RSHIFT-3 110101)

= 101010 OR (011101 AND 000110)

= 101010 OR 000100

= 101110

D. 101110

3. Recursive Functions

$f(14) = f(f(12) - 2) = f(10 - 2) = f(8) = 9$

$f(12) = f(f(10) - 2) = f(11 - 2) = f(9) = 10$

$f(10) = 10 + 1 = 11$

$f(9) = 9 + 1 = 10$

$f(8) = 8 + 1 = 9$

$f(11) = 11 = 1 = 12$

Therefore: $f(f(f(f(14)))) = f(f(f(9)))$

$= f(f(10))$

$= f(11)$

$= 12$

D. 12

4. Digital Electronics

The square gate receives three inputs.
They are: $\overline{A}$, $(\overline{AB} + B)\,C$, and $\overline{C}$.
The middle input simplifies as follows:

$$(\overline{AB} + B)\,C = (\overline{A} + \overline{B} + B)\,C = (\overline{A} + 1)\,C = C$$

A	C	$\overline{A}$	$\overline{C}$	*Gate Result*
0	0	1	1	0
0	1	1	0	0
1	0	0	1	1
1	1	0	0	1

Since B = *, there are 4 ordered triples that make the expression true: (1, *, 0) and (1, *, 1)

C. 4

5. Prefix-Infix-Postfix

```
/ + ^ / + 4 6 - 7 5 2 * 7 - 5 4 ^ / + 1 7 - 5 1 4
= /+^/(+ 4 6)(- 7 5)2*7(- 5 4)^/(+ 1 7)(- 5 1)4
= / + ^ (/ 10 2) 2 (* 7 1) ^ (/ 8 4) 4
= / + (^ 5 2) 7 (^ 2 4) = / (+ 25 7)(^ 2 4)
= / 32 16 = 2
```

B. 2

6. Computer Number Systems

$1978_{10} = 3672_8$ $2019_{10} = 3743_8$

The string "2" appears 14 time in the octal numbers:
3672, 3702, 3712, 3720, 3721, 3722, 3723, 3724, 3725, 3726, 3727, 3732, 3742

C. 14

7. What Does This Program Do?

The table shows the values x and y have:

x	-4	-3	-2	-1	0	1	2	3	4
y	-3	3	1	-1	-2	-6	-6	-6	-5

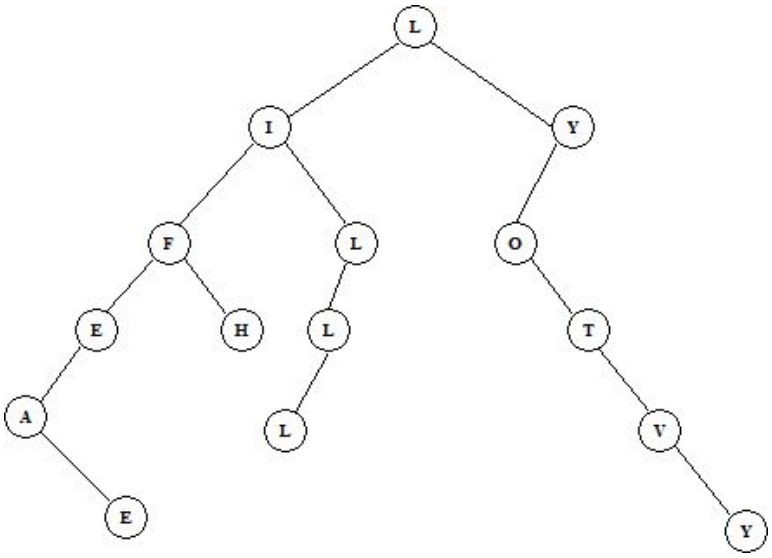
`-5 is the output for this program.`

B. -5

8. Data Structures

The following is the binary search for:

L I L Y O F T H E V A L L E Y



The nodes with only a left child are: Y, L, L, E

C. 4