



# American Computer Science League

2019-2020

Contest #4

## SENIOR DIVISION SOLUTIONS

### 1. Graph Theory

0	1	1	0	0
0	0	0	1	1
0	1	1	0	0
1	0	0	0	1
0	0	0	1	0

=

1	1	1	2	2
1	1	1	1	1
1	1	1	2	2
1	1	1	1	2
0	1	1	1	0

There are 7 from C: 1 from C to A, 1 from C to B, 1 from C to C, 2 from C to D and 2 from C to E. The answer is found by adding the values in the 3rd row.

1. 7

### 2. Graph Theory

There are 5 cycles: BDB, BEB, BDAB, BDEB, BDACB.

2. 5

### 3. Digital Electronics

The digital circuit translates to:

$$\begin{aligned}
 & \overline{(AB + (B + C))C} \\
 &= \overline{AB + (B + C)} + \overline{C} \\
 &= \overline{AB} \overline{(B + C)} + \overline{C} \\
 &= (\overline{A} + \overline{B}) \overline{B} \overline{C} + \overline{C} \\
 &= \overline{A} \overline{B} \overline{C} + \overline{B} \overline{C} + \overline{C} \\
 &= \overline{C} (\overline{A} \overline{B} + \overline{B} + 1) \\
 &= \overline{C}
 \end{aligned}$$

3.  $\overline{C}$   
or NOT C  
or  $\sim C$

#### 4. Digital Electronics

4. 6

The digital circuit translates to:

$$\begin{aligned} & \overline{(A + (B + C)) + (B + C) \overline{D}} \\ &= \overline{A} \overline{(B + C)} + \overline{(B + C)} + \overline{\overline{D}} \\ &= \overline{A} \overline{B} \overline{C} + \overline{B} \overline{C} + D \\ &= \overline{B} \overline{C} (\overline{A} + 1) + D \\ &= \overline{B} \overline{C} + D \end{aligned}$$

To be FALSE, all terms are FALSE.

$$A = *, D = 0, \overline{B} \overline{C} = 0$$

$$\Rightarrow (B = 1 \wedge C = 1) \vee (B = 1 \wedge C = 0) \vee (B = 0 \wedge C = 1)$$

Therefore, 6 quadruples make it FALSE:

(0, 0, 1, 0), (1, 0, 1, 0), (0, 1, 0, 0), (1, 1, 0, 0), (0, 1, 1, 0), (1, 1, 1, 0)

#### 5. Assembly Language

5. 11

The assembly programs can be converted to an equivalent program as follows:

```
X = 1
Z = 0
Z = Z + X * X
WHILE Z < 500
    X = X + 1
    Z = Z + X * X
END WHILE
PRINT X
END
```

This programs add the squares of the natural numbers until sum is greater than 500. This occurs when X = 11.