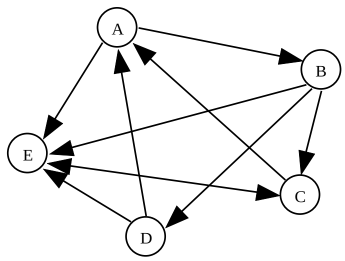
American Computer Science League

2017-2018 **Contest #4**

CLASSROOM DIVISION SOLUTIONS

1. Graph Theory
The directed graph formed is shown on the right.



1. As shown

2. Graph Theory

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

2. As shown

3. Digital Electronics

The digital circuit translates to: $\overline{AB+\overline{B}}$

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

3. $\overline{A}B$

4. Digital Electronics

The digital circuit translates to: $((\overline{A})(A+B)+\overline{BC})\overline{C}$

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

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

$\overline{C}=0$ and $C=1$ This makes $A=*$ and $B=*$.
This is true for 4 cases: (*, *, 1)

4. 4

5. What Does This Program Do?
First loop places letters greater than H and not T in B.
B = “NRRNSININS”. The second loop eliminates N’s and S’s from B and places the remaining letters in C. C = “RRII”. The print statement takes the first and last letters in C and concatenates them to produce RI.

5. RI

CLASSROOM DIVISION SOLUTIONS

6. Graph Theory

To find the number of paths of length 2, add the entries in the square of the adjacency matrix. The sum is 24.

$$\begin{vmatrix} 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \end{vmatrix}^2 = \begin{vmatrix} 0 & 1 & 1 & 2 & 1 \\ 1 & 1 & 1 & 1 & 2 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 2 & 0 & 1 & 2 \\ 1 & 0 & 2 & 1 & 2 \end{vmatrix}$$

6. 24

7. Graph Theory

The cycles are: ABDA, ABDCA, ADCA, ADA, BDB, and BDCB.

7. 6

8. Digital Electronics

The circuit translates to: $(\overline{A}+\overline{AB})\oplus B$

$$(\overline{A}+\overline{AB})\oplus B = \overline{(\overline{A}+\overline{AB})}B+(\overline{A}+\overline{AB})\overline{B} = (\overline{\overline{A}}(\overline{\overline{AB}}))B+(\overline{A}+(\overline{A}+\overline{B}))\overline{B}$$

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

Note: It would have been fewer steps if the first term had been simplified first.

8. $AB+\overline{B}$

9. Digital Electronics

The circuit translates to: $(\overline{A}(\overline{AB}))+(\overline{(BC)C})$

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

$$= \overline{A}+\overline{B}+\overline{C}\ .$$

This is FALSE when all three terms are 0, so $\overline{A}=0\wedge\overline{B}=0\wedge\overline{C}=0$.
The corresponding ordered triple is (1, 1, 1).

9. (1, 1, 1)

10. Assembly Language

This program converts a base ten number into a base 16 number by repeated division. The integral remainders are outputted.
$4213_{10} = 1075_{16}$ The sum of the digits outputted is 13.

10. 13