

## Intermediate and Classroom Shorts

<p><b>1. Boolean Algebra</b></p> <p>Simplify the following Boolean expression to use AND, OR, and NOT operators with no parentheses. How many OR operators are there?</p> $\overline{A + \overline{BC}} + \overline{B + \overline{AC}} + \overline{\overline{C}} + AB$	<p>A. 0 B. 1 C. 2 D. 3 E. None of the above</p>
<p><b>2. Boolean Algebra</b></p> <p>Define a new operator, \$, as follows: <math>A \\$ B = \overline{\overline{A} \overline{B} + A}</math></p> <p>It has the highest precedence among binary operators.</p> <p>How many ordered triples make the following FALSE?</p> $A \$ B + B \$ C + \overline{A} \$ \overline{C}$	<p>A. 0 B. 1 C. 3 D. 5 E. None of the above</p>
<p><b>3. Bit-String Flicking</b></p> <p>Evaluate the following bit string expression if</p> <p>X = 01101 and Y = 10110.</p> $(\text{RSHIFT-1 } (\text{LCIRC-3 } X)) \text{ OR } (\text{NOT } (\text{LSHIFT-1 } ((\text{RCIRC-2 } X) \& Y)))$	<p>A. 11111 B. 00101 C. 01101 D. 00000 E. None of the above</p>
<p><b>4. Bit-String Flicking</b></p> <p>How many different values of x (a bitstring of 5 bits) make the following equation true?</p> $(\text{LCIRC-2 } 01010) \text{ OR } (\text{RSHIFT-1 } ((\text{LCIRC-2 } X) \text{ AND } 01110)) = 01101$	<p>A. 0 B. 4 C. 8 D. 10 E. None of the above</p>

### 5. Recursive Functions

Find  $f(f(f(f(30))))$  where  $[x]$  is the greatest integer function:

$$f(x) = \begin{cases} 2 \cdot f\left(\left\lfloor \frac{x}{2} \right\rfloor\right) - 3 & \text{if } x \text{ is odd and } x \text{ is a multiple of } 3 \\ f(x+3) + 1 & \text{if } x \text{ is even and } x \text{ is a multiple of } 3 \\ x - 1 & \text{otherwise} \end{cases}$$

- A. 22
- B. 21
- C. 15
- D. 9
- E. None of the above

### 6. Recursive Functions

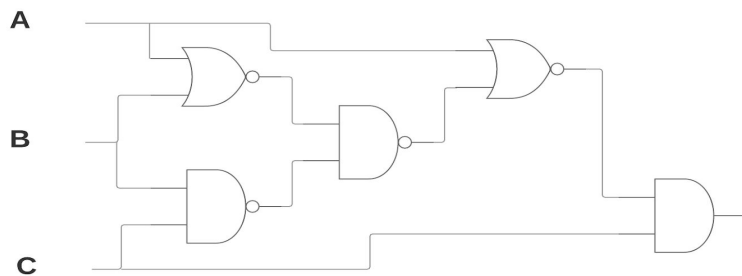
Find  $f(14, 20)$  given:

$$f(x, y) = \begin{cases} f(x+1, y-2) + f(y, x) + 1 & \text{if } x < y \\ f\left(f\left(\frac{x}{2}, y\right), \frac{x}{2}\right) - 3 & \text{if } x = y \\ x - y & \text{if } x > y \end{cases}$$

- A. 19
- B. 18
- C. 11
- D. 10
- E. None of the above


### 7. Digital Electronics

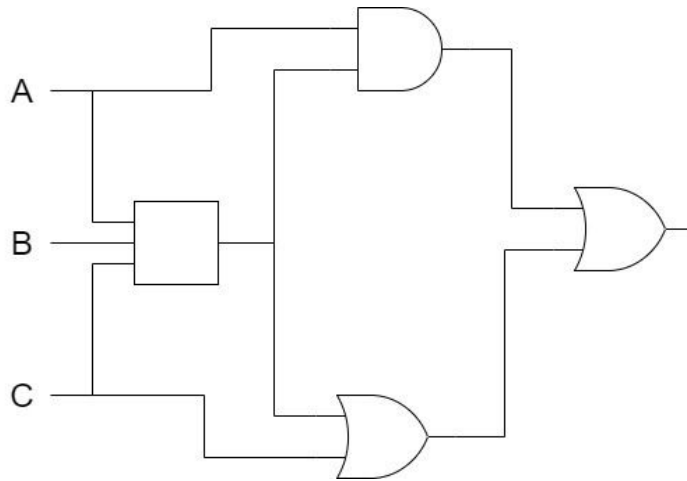
Find all ordered triples that make the following circuit TRUE. Your answer will be a single 3-character string in the format XYZ where each X Y Z is either 0, 1, or \* (e.g. 0\*1, 110, \*\*0).



- 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  $\{a, b\}$   
 $a \$ b$  = average of  $a$  and  $b$   
 $a \&$  = absolute value of  $a$

Evaluate this postfix expression if all numbers are single digits:

**2 4 # 4 2 \$ 5 - & + 8 2 \$ 7 3 \$ \* - &**

- A. 25
- B. 29
- C. 27
- D. 21
- E. None of the above

### 10. Prefix-Infix-Postfix

Evaluate this prefix expression if  $a = 1$ ,  $b = 3$ ,  $c = 5$ , and  $d = 2$ :

**\* / + a \* b c \* a ^ d 3 ^ b - c \* 3 a**

- A. 9
- B. 11
- C. 17
- D. 18
- E. None of the above

### 11. Computer Number Systems

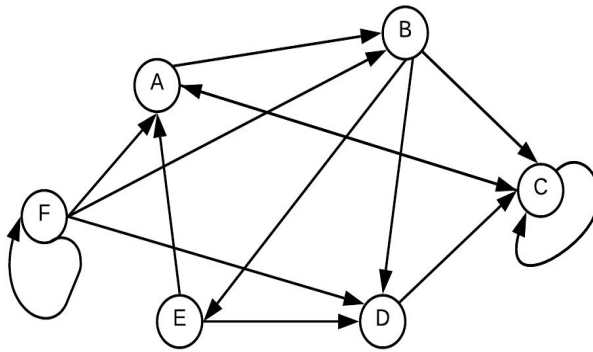
How many 1's are there in the binary representations of the decimal numbers 50 to 64 inclusive?

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

<p><b>12. Computer Number Systems</b></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><b>13. Data Structures</b></p> <p>What would be the next item popped given the following initially empty queue?</p> <p>PUSH(R), PUSH(H), PUSH(O), PUSH(D), POP(X), POP(X), PUSH(O), POP(X), PUSH(D), PUSH(E), PUSH(N), POP(X), PUSH(D), PUSH(R), POP(X), POP(X), PUSH(O), PUSH(N), POP(X), POP(X), POP(X)</p>	<p>A. D B. E C. N D. R E. None of the above</p>
<p><b>14. Data Structures</b></p> <p>How many nodes have only a left child in the binary search tree for:</p> <p style="text-align: center;"><b>CORONAVIRUS</b></p>	<p>A. 4 B. 5 C. 6 D. 8 E. None of the above</p>
<p><b>15. Graph Theory</b></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

Which two vertices have the most paths of length 2 between them?  
Write a 2-character string with the starting vertex followed by the ending vertex.



- A. FA
- B. AC
- C. FC
- D. BA
- 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. LISP**

After the following LISP program is run, what is the value of the last expression?

```
(SETQ Z '(C(O N)(N(E C)T)(I(C(U)T))))  
(SETQ Y (CAR (REVERSE (CDR (CDR Z)))))  
(CAR (CDR (CAR (CDR Y))))
```

- A. (C (U) T)
- B. (U)
- C. ((U) T)
- D. U
- E. None of the above

**19. FSAs and Regular Expressions**

Given the regular expression:

**[^aeiou]\* [aeiou] [fghj-np-t] +. (ing|full|age|less)?**

Which of the following strings are accepted?

- a. brush|ing
- b. help/ful
- c. fractals
- d. java
- e. python!
- f. shapeless
- g. igloo
- h. apple
- i. striving
- j. image

- A. a, b, d, e, f
- B. a, c, d, e, g, h
- C. a, b, e, f, h
- D. b, d, e, f, h, j
- E. None of the above

## 20. Assembly Language

How many different numbers are printed when the following program is run with input values 13, 24, 37, 45, 51, 60, 74, 0?

```
TOP      READ      N
          LOAD      N
          BE        STOP
          DIV        =10
          STORE     B
          MULT       =10
          STORE     X
          LOAD      N
          SUB        X
          STORE     C
          LOAD      B
          ADD        C
          STORE     M
          DIV        =3
          MULT       =3
          STORE     Y
          LOAD      M
          SUB        Y
          BE        DOWN
          BU        TOP
DOWN     LOAD      N
          PRINT     N
          BU        TOP
STOP     END
```

- A. 4
- B. 3
- C. 2
- D. 1
- E. None of the above

## 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？

$$\overline{A + \overline{BC}} + \overline{B + \overline{AC}} + \overline{\overline{C}} + AB$$

- A. 0
- B. 1
- C. 2
- D. 3
- E. 以上均不是正确答案

## 2. Boolean Algebra

定义一个新的运算符, \$, 如:  $A \$ B = \overline{A \overline{B} + A}$

在所有二进制运算符中, 它具有最高的优先级。

请问有多少个有序三元组能使下式为假？

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

- A. 0
- B. 1
- C. 3
- D. 5
- E. 以上均不是正确答案

## 3. Bit-String Flicking

计算下述位字符串表达式, 若

$$X = 01101, Y = 10110.$$

$$(\text{RSHIFT}-1 (\text{LCIRC}-3 X)) \text{ OR } (\text{NOT } (\text{LSHIFT}-1 ((\text{RCIRC}-2 X) \& Y)))$$

- A. 11111
- B. 00101
- C. 01101
- D. 00000
- E. 以上均不是正确答案

## 4. Bit-String Flicking

有多少个不同的x的值 (长度为5个字节) 能够使得下式为真？

$$\begin{aligned} & (\text{LCIRC}-2 01010) \text{ OR } \\ & (\text{RSHIFT}-1 ((\text{LCIRC}-2 X) \text{ AND } 01110)) \\ & = 01101 \end{aligned}$$

- A. 0
- B. 4
- C. 8
- D. 10
- E. 以上均不是正确的答案



5. Recursive Functions

求  $f(f(f(f(30))))$  , 其中  $[x]$  是最大的整数函数:

$$f(x) = \begin{cases} 2 \cdot f\left(\left\lfloor \frac{x}{2} \right\rfloor\right) - 3 & \text{if } x \text{ is odd and } x \text{ is a multiple of } 3 \\ & \text{如果 } x \text{ 是奇数, 且是 } 3 \text{ 的倍数} \\ f(x+3) + 1 & \text{if } x \text{ is even and } x \text{ is a multiple of } 3 \\ & \text{如果 } x \text{ 是偶数, 且是 } 3 \text{ 的倍数} \\ x - 1 & \text{otherwise} \\ & \text{其他} \end{cases}$$

- A. 22
- B. 21
- C. 15
- D. 9
- E. 以上均不是正确答案

6. Recursive Functions

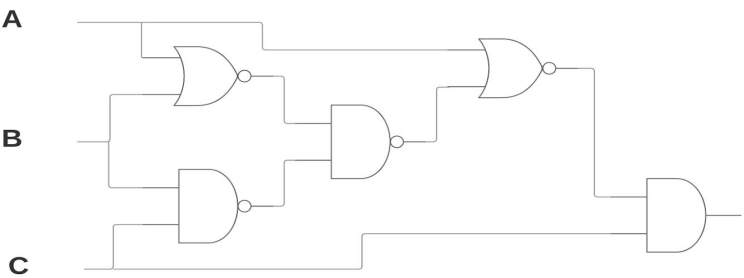
求  $f(14, 20)$  :

$$f(x, y) = \begin{cases} f(x+1, y-2) + f(y, x) + 1 & \text{if } x < y \\ f\left(f\left(\frac{x}{2}, y\right), \frac{x}{2}\right) - 3 & \text{if } x = y \\ x - y & \text{if } x > y \end{cases}$$

- A. 19
- B. 18
- C. 11
- D. 10
- E. 以上均不是正确答案


7. Digital Electronics

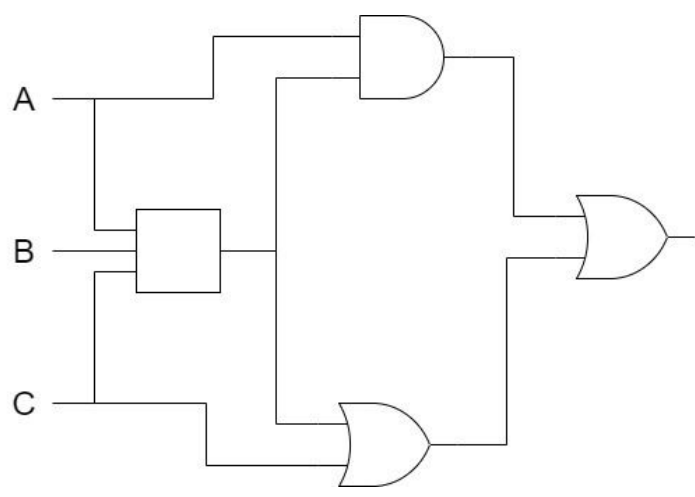
求出能够使得如下电路为真的所有的有序三元组。你的回答格式应为XYZ此类3个字符的字符串，在字符串XYZ中，每个字符X Y Z的值要么是0要么是1，或者是\*(e.g. 0\*1, 110, \*\*0)。



- 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。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。请问有多少个有序三元组可以使下列数字电路为真?



- 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  
 $a \$ b = a$  和  $b$  的平均值  
 $a \& = a$  的绝对值

若所有的数字都是单独的数字, 请计算下述后缀表达式的值:

$2\ 4\ \#\ 4\ 2\ \$\ 5\ -\ \&\ +\ 8\ 2\ \$\ 7\ 3\ \$\ * - \&$

- A. 25
- B. 29
- C. 27
- D. 21
- E. 以上均不是正确答案

10. Prefix-Infix-Postfix

若  $a = 1, b = 3, c = 5, d = 2$ , 请计算下列前缀表达式的值:

$/ + a * b c * a ^ d 3 ^ b - c * 3 a$

- A. 9
- B. 11
- C. 17
- D. 18
- E. 以上均不是正确答案

11. Computer Number Systems

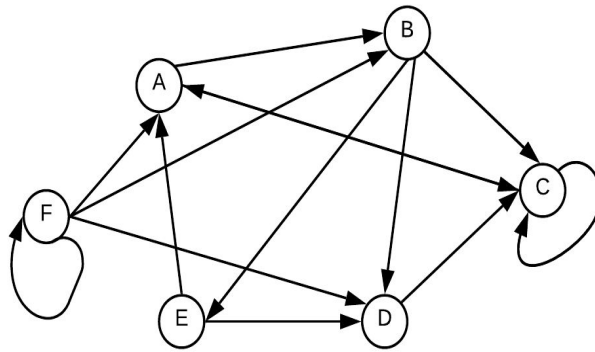
从50到64 ( 包括50和64 ) 的十进制数在二进制表示下一共有多少个1?

- A. 56
- B. 60
- C. 62
- D. 70
- E. 以上均不是正确答案

<p><b>12. Computer Number Systems</b></p> <p>计算下列式子的值，并用十六进制表示该结果。</p> $2020_8 - 202_8 - 20_8 + 2_8$	<p>A. 700 B. 1F0 C. 380 D. 160 E. 以上均不是正确答案</p>
<p><b>13. Data Structures</b></p> <p>给定初始为空的队列，请问执行完所有指令时，下一个弹出项是什么？</p> <p>PUSH(R), PUSH(H), PUSH(O), PUSH(D), POP(X), POP(X), PUSH(O), POP(X), PUSH(D), PUSH(E), PUSH(N), POP(X), PUSH(D), PUSH(R), POP(X), POP(X), PUSH(O), PUSH(N), POP(X), POP(X), POP(X)</p>	<p>A. D B. E C. N D. R E. 以上均不是正确答案</p>
<p><b>14. Data Structures</b></p> <p>二叉搜索树中有多少个结点仅有一个左孩子结点：</p> <p>CORONAVIRUS</p>	<p>A. 4 B. 5 C. 6 D. 8 E. 以上均不是正确答案</p>
<p><b>15. Graph Theory</b></p> <p>下列给定的邻接矩阵表示的图中有多少个环？</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. 以上均不是正确答案</p>

## 16. Graph Theory

在下面图中，有哪两个顶点，在它们间有最多条长度为2的路径？并写出包含2个字符（开始结点和结束结点）的字符串。



- A. FA
- B. AC
- C. FC
- D. BA
- 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. LISP

执行以下 LISP 程序后，请问最终表达式的值是多少？

```
(SETQ Z '(C(O N)(N(E C)T)(I(C(U)T))))  
(SETQ Y (CAR (REVERSE (CDR (CDR Z)))))  
(CAR (CDR (CAR (CDR Y))))
```

- A. (C (U) T)
- B. (U)
- C. ((U) T)
- D. U
- E. 以上均不是正确答案

19. FSAs and Regular Expressions

给定下列正则表达式：

```
[^aeiou]* [aeiou] [fghj-np-t] +. (ing|full|age|less)?
```

请问能接受以下哪些字符串？

- a. brush|ing

b. help/ful

c. fractals

d. java

e. python!
- f. shapeless

g. igloo

h. apple

i. striving

j. image

- A. a, b, d, e, f
- B. a, c, d, e, g, h
- C. a, b, e, f, h
- D. b, d, e, f, h, j
- E. 以上均不是正确答案

20. Assembly Language

用输入值 13, 24, 37, 45, 51, 60, 74, 0 来运行此程序后，会打印输出多少个不同的数字？

TOP	READ	N
	LOAD	N
	BE	STOP
	DIV	=10
	STORE	B
	MULT	=10
	STORE	X
	LOAD	N
	SUB	X
	STORE	C
	LOAD	B
	ADD	C
	STORE	M
	DIV	=3
	MULT	=3
	STORE	Y
	LOAD	M
	SUB	Y
	BE	DOWN
	BU	TOP
DOWN	LOAD	N
	PRINT	N
	BU	TOP
STOP	END	

- A. 4
- B. 3
- C. 2
- D. 1
- E. 以上均不是正确答案