1. BASIC Expressions

What is the value of the following BASIC expression given that a=2, b=6, and c=−1.

$$\texttt{a} + \texttt{b} * (\texttt{c} + \texttt{a}) - \texttt{b}\uparrow 2/(\texttt{a} + \texttt{c})$$

2. BASIC Expressions

Write a BASIC statement that is an *exact* translation of the following:

The value x equals the sum of a and b divided by twice the difference of c and d

3. What Does This Program Do? (BASIC)

If variables a, b, and c all start out with a value of 2, which, if any, of them have a value of 2 after the program finishes?

```
if (a+b)>c then a=b+c else a=c-b
if a>(b+c) then b=a-c else b=a+c
if a+b>b-c then c=a+b else a=b-c
if a+b>c then a=b+c else c=b-a
```

4. What Does This Program Do? (BASIC)

What is printed when the following program is run?

```
10 A=1 : B=3 : C=1
20 if (A>B) and ((C<A) or (B<C)) then A = A+3
30 if (A<B) and (B>C) then A = A+C
40 if ((A>C) and (A>B)) or (B>C) then A = A-C
50 if A>5 then A=A+2 else A=A+5
60 print A
70 end
```

5. Computer Number Systems

How many 1's are there in the binary representation of 1996?

6. Computer Number Systems

What is the base 16 value of $\text{FEDCBA}_{16} + \text{ABCDEF}_{16}$?

7. Computer Number Systems

How many numbers between 300 and 500, inclusive, have exactly eight 1's in their binary representation?

8. Recursive Functions

Find $f(7)$, given the following:

$$f(x) = \begin{cases} f(x-3)+1 & \text{if } x \geq 3 \\ f(x+2)-3 & \text{if } 1 \leq x < 3 \\ x^2+x+1 & \text{otherwise} \end{cases}$$

9. Recursive Functions

Find $f(8,5)$, given the following:

$$f(x,y) = \begin{cases} f(x-1,y+1)-2 & \text{if } x \text{ and } y \text{ are positive,} \\ & x \text{ is even, and } y \text{ is odd} \\ f(y,x+1)+1 & \text{if } x \text{ and } y \text{ are positive,} \\ & x \text{ is odd, and } y \text{ is even} \\ 7 & \text{if } x \text{ and } y \text{ are both zero} \\ xy & \text{otherwise} \end{cases}$$

10. Recursive Functions

Find $f(15)$, given the following:

$$f(x) = \begin{cases} 2 * f(x-3)-4 & \text{if } x \text{ is composite} \\ x^2+x & \text{if } x \text{ is prime} \end{cases}$$

1. Here is the evaluation of the expression:

$$\begin{aligned} \texttt{a} + \texttt{b} * (\texttt{c} + \texttt{a}) - \texttt{b}\uparrow 2/(\texttt{a} + \texttt{c}) &= 2 + 6/(-1 + 2) - 6\uparrow 2(2 + -1) \\ &= 2 + 6/1 - 36/1 \\ &= 8 - 36 \\ &= -28 \end{aligned}$$

-28

2. The statement shown on the right is the only correct translation. Note that the parentheses are needed around the term `2*(c-d)` because division and multiplication have equal precedence, and bind from left-to-right. Without the parentheses, the value of x would be "the average of a and b times the difference of c and d."

```
x = (a+b)/(2*(c-d))
```

3. The following table shows the values of the variables after each `if` statement is executed:

`if?`	`a`	`b`	`c`
true	4	2	2
false	4	6	2
true	4	6	10
false	4	6	2

`c`

4. The following table shows the value of variable `A` after each line is executed.

line	if?	`A`
20	false	1
30	true	4
40	true	1
50	false	6

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5. First convert 1996 to hex, 1996=$7CC_{16}$, and then convert that to binary:

$$7CC_{16} = 0111\ 1100\ 1100$$

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6. Work from the right to the left, carrying as needed:

$$\begin{aligned} \text{F} + \text{A} &= 19 \\ \textit{carry} + \text{E} + \text{B} &= 1\text{A} \\ \textit{carry} + \text{D} + \text{C} &= 1\text{A} \\ \textit{carry} + \text{C} + \text{D} &= 1\text{A} \\ \textit{carry} + \text{B} + \text{E} &= 1\text{A} \\ \textit{carry} + \text{A} + \text{F} &= 1\text{A} \end{aligned}$$

$1AAAAA9_{16}$

7. Convert 300 and 500 to binary:

$$300 = 100101100$$
$$500 = 111110100$$

There are 9 bits in both of these numbers, so all the numbers between 300 and 500 also have 9 bits. The 9-bit long binary numbers in this range with eight 1's are as follows:

$$383 = 101111111$$
$$447 = 110111111$$
$$479 = 111011111$$
$$495 = 111101111$$

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8. The evaluation is as follows:

$$f(7) = f(4) + 1$$
$$f(4) = f(1) + 1$$
$$f(1) = f(3) - 3$$
$$f(3) = f(0) + 1$$
$$f(0) = 0^2 + 0 + 1 = 1$$

Working backwards, we have $f(3) = 2$, $f(1) = -1$, $f(4) = 0$, and $f(7) = 1$.

1

9. The evaluation is as follows:

$$f(8,5) = f(7,6) - 2$$
$$f(7,6) = f(6,8) + 1$$
$$f(6,8) = 48$$

Therefore, $f(7,6) = 49$ and $f(8,5) = 47$. Note that the evaluation of $f(x,y)$ never requires more than 3 steps for any values of x and y.

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10. The evaluation is as follows:

$$f(15) = 2f(12) - 4$$
$$f(12) = 2f(9) - 4$$
$$f(9) = 2f(6) - 4$$
$$f(6) = 2f(3) - 4$$
$$f(3) = 3^2 + 3 = 12$$

Working backwards, we have $f(6) = 20$, $f(9) = 36$, $f(12) = 68$, and $f(15) = 132$.

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