Question 1 (10 points) For each of the following, answer **True** or **False** as appropriate:

1. The basic electronic device used to build logic gates is called a transistor. __TRUE________

2. 8-bits have 255 unique binary patterns. __FALSE________

3. Faster computers can compute more things than slower ones. __FALSE________

4. A voltage of 0 volts represents a binary digit 1 in the CPU. __FALSE________

5. A voltage of 1.2 volts represents a binary digit 0 in the CPU. __FALSE________

6. The idea of a universal computing device was developed by John von Neumann __FALSE________

7. The Difference Engine was developed at the University of Pennsylvania in the 1940s. __FALSE________

8. The hexadecimal number system is a positional number system. __TRUE________

9. The Roman number system is a positional number system. __FALSE________

10. The XOR gate is logically complete. __FALSE________

Question 2 (20 points) Convert the following numbers as specified.

1. $(77)_{10}$ to base-2 (8-bits) ___0100 1101_____
2. $(-77)_{10}$ to base-2 (8-bits 2's complement representation) ___1011 0011_____
3. $(77)_{10}$ to base-16 ___4D_____
4. $(77)_8$ to base-10 ___63_____
5. $(77)_{16}$ to base-10 ___119_____
6. $(-34)_{10}$ to base-2 (8-bits 2's complement representation) ___11011110_____
7. $(-34)_{10}$ to base-2 (16-bits 2's complement representation) 1111 1111 1101 1110
8. $(01011111)_2$ to base-16 ___5F_____
9. $(01011111)_2$ to base-10 ___95_____
10. 8-bit, 2's complement $(11011111)_2$ to base-10 ___-33_____

Question 3 (25 points) Below, use the latest value in each variable from the previous question (Note: In C/Java both **`int`** and **`float`** in Java use 32-bits to represent values):

(a) Consider the C/Java statement:

```
int x = 4230;
```

Show the <u>precise</u> representation (in bits) that will be used to store the value of **x**.

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

(b) Next, consider the statement:

```
int y = -x * 2; // y = -8460
```

Show the <u>precise</u> representation (in bits) that will be used to store the value of **y**.

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

(c) Next, consider the statement:

```
int a = x + y;   // a = -4230
```

Show the <u>precise</u> representation (in bits) that will be used to store the value of **a**.

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

(d) Next, consider the statement:

```
float w = x/2.0; // w = 2115.0 (2115 = 100 0010 0011)
```

Show the <u>precise</u> representation (in bits) that will be used to store the value of **w**.

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

(e) Next, consider the statement:

```
float z = -w * 3; // z = -6345.0 (6345 = 1 1000 1100 1001)
```

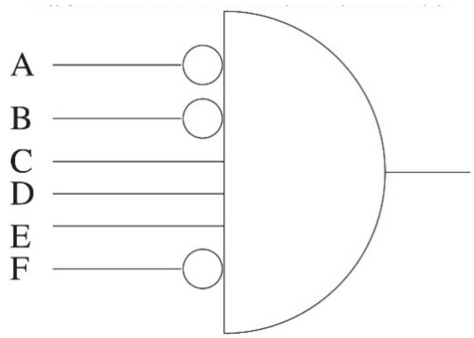
Show the <u>precise</u> representation (in bits) that will be used to store the value of **z**.

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

Question 4 (10 points)

(a) For what values of ABCDEF will the output of the six-input AND gate be 1? __001 110_____

Also, what decimal value does that represent? Assume that A is the leftmost bit. __14____



(b) How many rows will there be in the Truth Table for the function above? __64 (2^6)___

(c) How many output lines will a five-input decoder have? __32 (2^5)___

(c) How many output lines will a 16-input MUX have? __1_______

How many Select lines will this MUX have? __4________

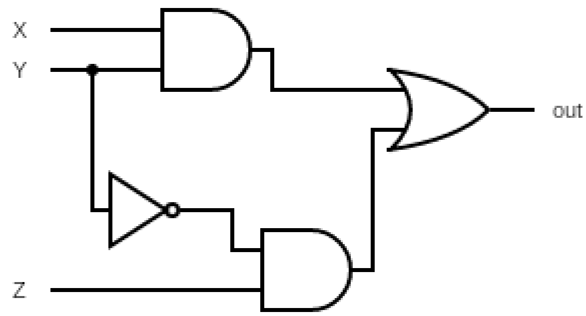
(d) If the code for the letter `'A'` is 65 and for `'a'` is 97 and, you are given the following in C/Java:

```
char upper = <some uppercase letter>;
char lower;
```

Write the C/Java expression you can use to convert a letter in **upper** to the corresponding lowercase letter and store it in **lower**.

lower = upper + 32;

Question 5 (10 points) (A) Complete the Truth Table for the following circuit diagram:



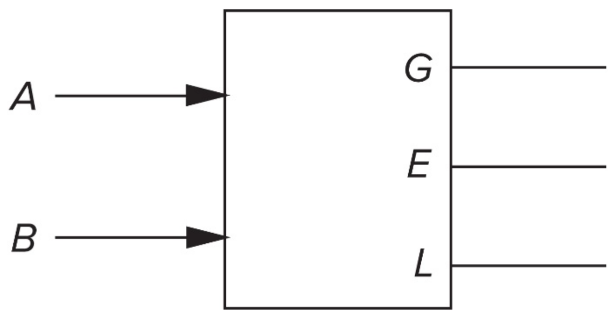
X	Y	Z	out
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

(B) How many total transistors does the circuit shown above use? __20_______

Question 6 (10 points) A comparator circuit has two 1-bit inputs A and B and three 1-bit outputs G (greater), E (equal), and L (less than). Here is how the outputs are described:

G is 1 if A > B	E is 1 if A = B	L is 1 if A < B
0 otherwise	0 otherwise	0 otherwise

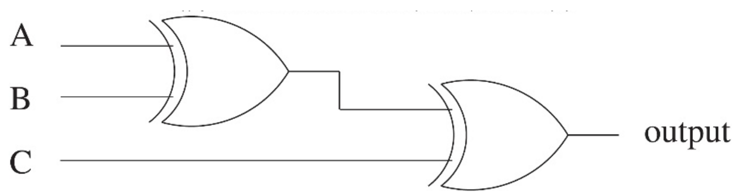
Here is a functional block diagram of a comparator:



Complete the truth table for the 1-bit comparator described above.

A	B	G	E	L
0	0	**0**	**1**	**0**
0	1	**0**	**0**	**1**
1	0	**1**	**0**	**0**
1	1	**0**	**1**	**0**

Question 7 (15 points) The following logic circuit consists of two XOR gates. Fill in the Output truth table below.



A	B	C	Output
0	0	0	**0**
0	0	1	**1**
0	1	0	**1**
0	1	1	**0**
1	0	0	**1**
1	0	1	**0**
1	1	0	**0**
1	1	1	**1**