CMSC 240 Principles of Computer Organization
Spring 2025
Exam 1

This exam contains 7 questions (9 numbered pages).

This is a closed book, closed notes, no devices exam.

If you have any devices (laptop, tablet, phone, calculator, etc), please put them in your backpack and place it in front of the room. Collect it after you have submitted your completed exam. Thank you.

Please answer all questions in the space provided. You may use the back of page(s) for some scratch work.

The exam will end exactly 80 minutes after it begins.

Good Luck!

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 binary number system is a positional number system. ____TRUE____

10. The NOR gate is logically complete. ____TRUE____

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) ___1101 1110___
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 precise 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	1	0	0	0	0	1	0	0	0	0	1	1	0

(b) Next, consider the statement:

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

Show the precise 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;
```

Show the precise 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;
```

Show the precise 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;
```

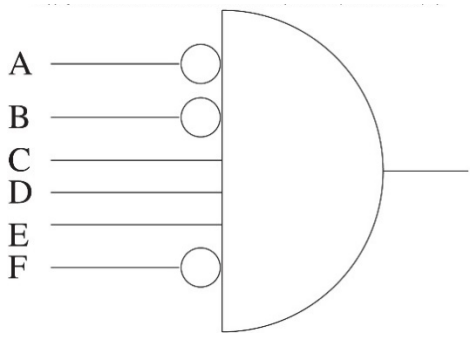
Show the precise representation (in bits) that will be used to store the value of **z**.

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_____

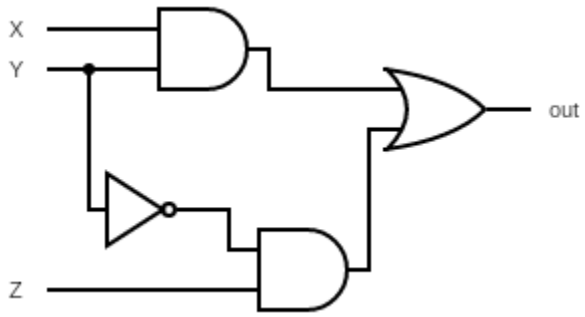
(d) If the code for the letter **`'A'`** is 65 and for **`'a'`** is 97 and, you are given the following in C/Java:

```
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:



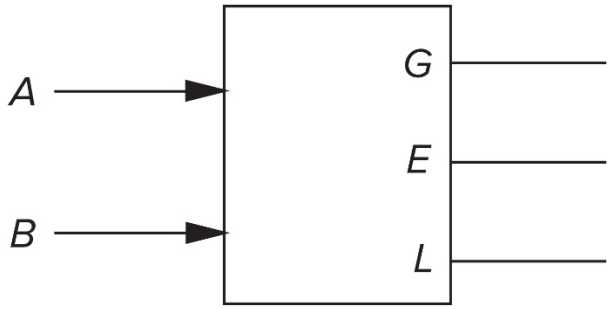
X	Y	Z	out
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

(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

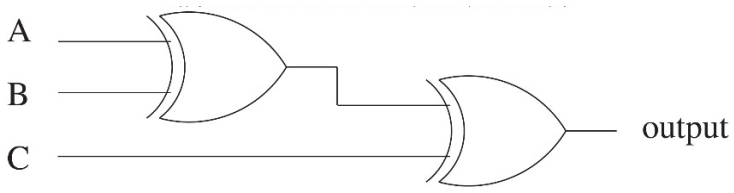
Here is a functional block diagram of a comparator:



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**

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EXAM 1: Grade Sheet

PLEASE do not write anything on this page. Thank you.

Question	Points	Max
1		10
2		20
3		25
4		10
5		10
6		10
7		15
Total		100