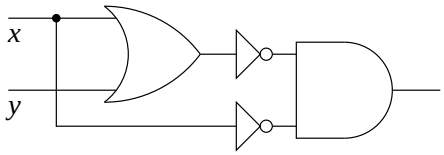
Exam 0, CSCI 150, Fall 2003

Name: _____

1. [5 pts] Write the Boolean expression most closely corresponding to the following circuit.



2. [10 pts]

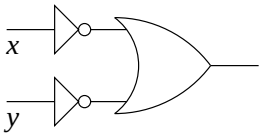
a. Give a sum-of-products Boolean expression corresponding to the truth table at right.

b. Simplify your expression.

c. At far right, draw a circuit corresponding to your expression.

x	y	z	out
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

3. [5 pts] At right, draw a smaller circuit (i.e., fewer gates) accomplishing the same task as the circuit at left (which represents $\overline{x} + \overline{y}$).



4. [10 pts] Perform each of the following conversions.

a. $35_{(10)}$ to binary

b. $1101100_{(2)}$ to decimal

c. $1101100_{(2)}$ to octal

d. $1101100_{(2)}$ to hexadecimal

e. $2D_{(16)}$ to binary

5. [5 pts] How many bits are in a kilobyte of memory?

6. [5 pts] Represent each of the following integers as specified.

a. -1 in a 7-bit two's-complement format

b. -36 in a 7-bit two's-complement format

c. 36 in a 7-bit two's-complement format

7. [10 pts] Suppose we define a seven-bit floating point system with one sign bit, three exponent bits (using excess 3), and three mantissa bits.

a. Represent each of the following decimal numbers in this seven-bit system.

$10_{(10)}$

$-0.25_{(10)}$

b. For each of the following bit patterns in this seven-bit floating-point system, express its numerical equivalent as a base-10 decimal number or as a base-10 fraction.

1 110 110

0 010 110

8. [10 pts] Draw a truth table diagramming a full adder's c_{out} output.

9. [10 pts] At right, draw a circuit with a single input T and a single output, where the output toggles each time T changes from 0 to 1. (Your circuit may incorporate D flip-flops.)

T	Q	explanation
0	0	
1	1	T changes to 1, so Q changes
0	1	T changes to 0; Q remains at 1
1	0	T changes to 1, so Q changes
0	0	T changes to 0; Q remains at 0
1	1	T changes to 1, so Q changes
0	1	T changes to 0; Q remains at 1
1	0	T changes to 1, so Q changes

10. [5 pts] Explain in detail what HYMN does during the fetch phase of the fetch-execute cycle. (Your explanation should describe how the computer accesses values in registers and memory.)

11. [15 pts] Suppose that HYMN begins with the following in memory.

addr	data	translation	
00000	100 01001	LOAD	01001
00001	010 01000	JZER	01000
00010	110 01010	ADD	01010
00011	101 01010	STORE	01010
00100	100 01001	LOAD	01001
00101	110 00000	ADD	00000
00110	101 00000	STORE	00000
00111	001 00000	JUMP	00000
01000	000 00000	HALT	
01001	000 00001	1	
01010	000 00010	2	
01011	000 00100	4	
01100	000 00000	0	

a. In the above table, list all new values stored in memory as the program executes. Express your answers in binary or hexadecimal.

b. What values does the AC hold in the course of executing this program? Express your answers in binary or hexadecimal.

12. [10 pts] Translate the following assembly language program into machine language.

```
up:   READ
      JZER done
      STORE n
      JUMP up
done: LOAD n
      WRITE
      HALT
n:    0
```

addr	data
00000	
00001	
00010	
00011	
00100	

addr	data
00101	
00110	
00111	
01000	
01001	

code	op	behavior
000	HALT	nothing further happens (computer halts)
001	JUMP	PC $\leftarrow$ $data$
010	JZER	**if** AC $= 0$ **then** PC $\leftarrow$ $data$ **else** PC $\leftarrow$ PC $+ 1$
011	JPOS	**if** AC > 0 **then** PC $\leftarrow$ $data$ **else** PC $\leftarrow$ PC $+ 1$
100	LOAD	AC $\leftarrow$ $\mathbf{M}[data]$; PC $\leftarrow$ PC $+ 1$
101	STORE	$\mathbf{M}[data]$ $\leftarrow$ AC; PC $\leftarrow$ PC $+ 1$
110	ADD	AC $\leftarrow$ AC $+ \mathbf{M}[data]$; PC $\leftarrow$ PC $+ 1$
111	SUB	AC $\leftarrow$ AC $- \mathbf{M}[data]$; PC $\leftarrow$ PC $+ 1$

13. [10 pts] Write an assembly language program that reads a number n from the user and then displays n's absolute value. (The **absolute value** of a number is that number with any negative sign removed. The absolute value of -5 is 5, while the absolute value of 3 is 3 itself.)

14. [10 pts] Translate the following pseudocode into an assembly language program.

Initialize sum to 0.
Read n.
while $n \neq 0$, **do:**
    Increase sum by n.
    Read n.
end while
Write sum.
Stop.

Solutions, Exam 0, CSCI 150, Fall 2003

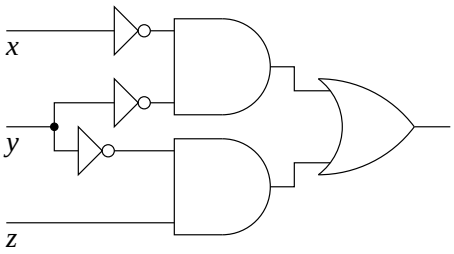
	Statistics
mean	86.346 (2245.000/26)
stddev	23.329
median	90.500
midrange	68.000-107.000
#1.	3.81 / 5
#2.	9.27 / 10
#3.	3.12 / 5
#4.	8.88 / 10
#5.	2.50 / 5
#6.	3.88 / 5
#7a.	3.96 / 5
#7b.	3.35 / 5
#8.	4.27 / 10
#9.	5.88 / 10
#10.	2.27 / 5
#11.	5.23 / 15
#12.	8.00 / 10
#13.	5.77 / 10
#14.	6.54 / 10
+ 10-point bonus	

1. $(\overline{x+y})\,\bar{x}$

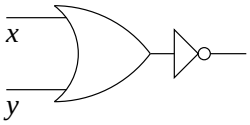
2. **a.** $\bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + x\bar{y}z$

b. $\bar{x}\bar{y} + \bar{y}z$

c.



3. This involves an application of DeMorgan's law $\overline{xy} = \bar{x} + \bar{y}$.



4. **a.** $35_{(10)} = 100011_{(2)}$

b. $1101100_{(2)} = 108_{(10)}$

c. $1101100_{(2)} = 154_{(8)}$

d. $1101100_{(2)} = 6\text{C}_{(16)}$

e. $2\text{D}_{(16)} = 10\,1101_{(2)}$

5.

$$\frac{\text{8 bits}}{\text{byte}} \times \frac{\text{1,024 bytes}}{\text{KB}} \times = \frac{\text{8,096 bits}}{\text{KB}}$$

6. **a.** 1111111

b. 1011100

c. 0100100

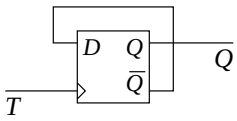
7. **a.** $5_{(10)}$ 0 110 010
$-2_{(10)}$ 1 001 000

b. 1 110 110 $-14_{(10)}$
0 010 110 $0.875_{(10)}$ or $\frac{7}{8}$

8.

c_{in}	a	b	c_{out}
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

9.



10. The CPU looks in the PC for a memory address, loads from memory at that address, and stores the data found there into the IR.

11. **a.**

addr	data
00000	8A 8B 8C
01010	03 06 0A

b. 01 03 89 8A 03 06 8A 8B 06 0A 8B 8C 0A

12.

addr	data	translation
00000	100 01010	LOAD 11110
00001	010 01000	JZER 00100
00010	101 01011	STORE 00111
00011	001 01011	JUMP 00000
00100	100 00000	LOAD 00111
00101	101 01010	STORE 11111
00110	000 00000	HALT
00111	000 00000	0

13.

```
    READ
    JPOS ok
    STORE n
    SUB n
    SUB n
ok: WRITE
    HALT
n:  0
```

14.

```
       LOAD zero     # Initialize sum to 0
       STORE sum
       READ          # Read n
       STORE n
up:    LOAD n        # while n /= 0, do:
       JZER done
       LOAD sum      #     Increase sum by n.
       ADD n
       STORE sum
       READ          #     Read n
       STORE n
       JUMP up       # end while
done:  LOAD sum      # Write sum.
       WRITE
       HALT          # Stop.
zero:  0
sum:   0
n:     0
```