Practice Test 1 Solutions

February 1, 2022

This practice test is not graded.

1. Convert 100_{10} into an unsigned binary number. `1100100`
2. Convert 100_{10} into a hexadecimal number. `0x64`
3. Convert 100_{10} into a base 3 number. 10201_3
4. What is the standard range of numbers that can be represented by an 8 bit *unsigned* binary number? $[0, 255]$
5. What is the standard range of numbers that can be represented by a 10 bit *signed* binary number? $[-512, 511]$
6. How many bits are needed to represent -200 as two's complement binary number? `9`
7. Convert -200_{10} into a 12 bit two's complement binary number. `111100111000`
8. Convert the unsigned binary number 11001110 into decimal. `206`
9. Convert the unsigned binary number 1100000011011110 into hexadecimal. `0xC0DE`
10. Convert 1234_5 to decimal. 194_{10}
11. Convert `0xBAD4F00D` to binary. `10111010110101001111000000001101`
12. Compute `0xBA & 0xAC`. `0xA8`
13. Multiply the binary number `10111` by four. `1011100`
14. Given 28 students in a class, how many bits are required to store a unique ID for each student? `5`
15. Convert the 10 bit two's complement binary number 1101100100 to decimal. `-156`
16. Write the six binary numbers that follow 1101.

    1) `1110`
    2) `1111`
    3) `10000`
    4) `10001`
    5) `10010`
    6) `10011`

17. Write the six two's complement binary numbers that precede 0010.

    1) `0001`
    2) `0000`
    3) `1111`
    4) `1110`
    5) `1101`
    6) `1100`

18. Write the eight hexadecimal numbers that follow `0x1C99`.

    1) `0x1C9A`
    2) `0x1C9B`
    3) `0x1C9C`
    4) `0x1C9D`
    5) `0x1C9E`
    6) `0x1C9F`
    7) `0x1CA0`
    8) `0x1CA1`

19. Add $10110 + 01101$ in binary. Assuming 5-bit arithmetic, was there overflow if the inputs are

    (a) unsigned numbers? Yes.

    (b) signed numbers? No.

The most important thing is that you demonstrate the *process*. It is not sufficient to simply translate to base 10 then back to binary.

```
 11
 10110
+01101
------
100011
```

20. Add $133_4 + 321_4$ in base 4.

The most important thing is that you demonstrate the *process*. It is not sufficient to simply translate to base 10 then back to base 4.

```
 11
 133
+321
------
1120
```

21. Complete the following truth tables:

A	B	C	$(A \oplus B) \oplus C$
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

A	B	C	$\bar{A}\bar{B} + B(A + \bar{C}) + \overline{BC}$
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

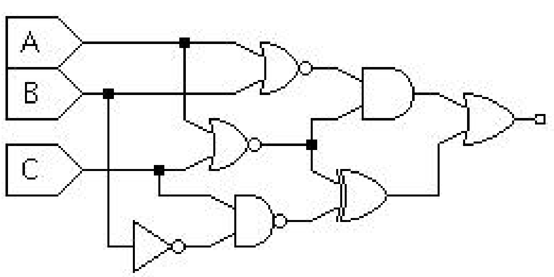
22. Draw the logic diagrams for the following boolean expressions:

    (a) $\bar{A}\bar{B} + B(A + \bar{C}) + \overline{BC}$

    (b) $\bar{X} + X(X + \bar{Y})(Y + \bar{Z})$

    (c) $(A + B)\overline{(\bar{A} + \bar{B})}$

23. Write a Boolean expression that describes this circuit:



$$((\overline{A + B})(\overline{A + C})) + ((\overline{A + C}) \oplus (\overline{\bar{B}C}))$$

24. Given that {AND, OR, NOT} is logically complete, show that {AND, NOT} is logically complete.

Create a NAND gate by connecting the output of an AND gate to the input of a NOT gate. We have previously shown {NAND} to be logically complete. Because {NAND} is logically complete, and we can construct {NAND} using only gates from the set {AND, NOT} we know that {AND, NOT} is also logically complete.

25. Design a circuit that returns true if the input represents the integer 10, and false otherwise.

10 is 1010 in binary. Call your four inputs A, B, C, and D. The circuit is simply four input AND gate with the following inputs: A, not B, C, and not D.

26. Use Boolean algebra, including DeMorgan's laws to show the equivalence of each pair of expressions. Show all your work. You may not use truth tables.

(a) $\bar{X} + X(X + \bar{Y})(Y + \bar{Z}) \Longleftrightarrow \bar{X} + Y + \bar{Z}$

$\bar{X} + (XX + X\bar{Y})(Y + \bar{Z})$
$\bar{X} + (X + X\bar{Y})(Y + \bar{Z})$
$\bar{X} + X(1 + \bar{Y})(Y + \bar{Z})$
$\bar{X} + X(1)(Y + \bar{Z})$
$\bar{X} + X(Y + \bar{Z})$
$\bar{X} + Y + \bar{Z}$

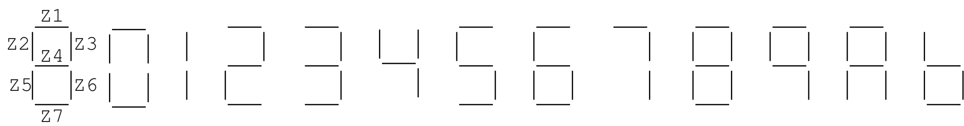
(b) $(A + B)\overline{(\bar{A} + \bar{B})} \Longleftrightarrow AB$

$(A + B)(\bar{\bar{A}}\bar{\bar{B}})$
$(A + B)(AB)$
$AAB + BAB$
$AB + AB$
AB

(c) $(B + \bar{C} + \bar{A}B)(BC + A\bar{B} + AC) \Longleftrightarrow BC + A\bar{B}\bar{C}$

$B(BC + A\bar{B} + AC) + \bar{C}(BC + A\bar{B} + AC) + \bar{A}B(BC + A\bar{B} + AC)$
$(BBC + BA\bar{B} + BAC) + (\bar{C}BC + \bar{C}A\bar{B} + \bar{C}AC) + (\bar{A}BBC + \bar{A}BA\bar{B} + \bar{A}BAC)$
$(BC + 0 + ABC) + (0 + A\bar{B}\bar{C} + 0) + (\bar{A}BC + 0 + 0)$
$(BC + ABC + \bar{A}BC) + A\bar{B}\bar{C}$
$BC + A\bar{B}\bar{C}$

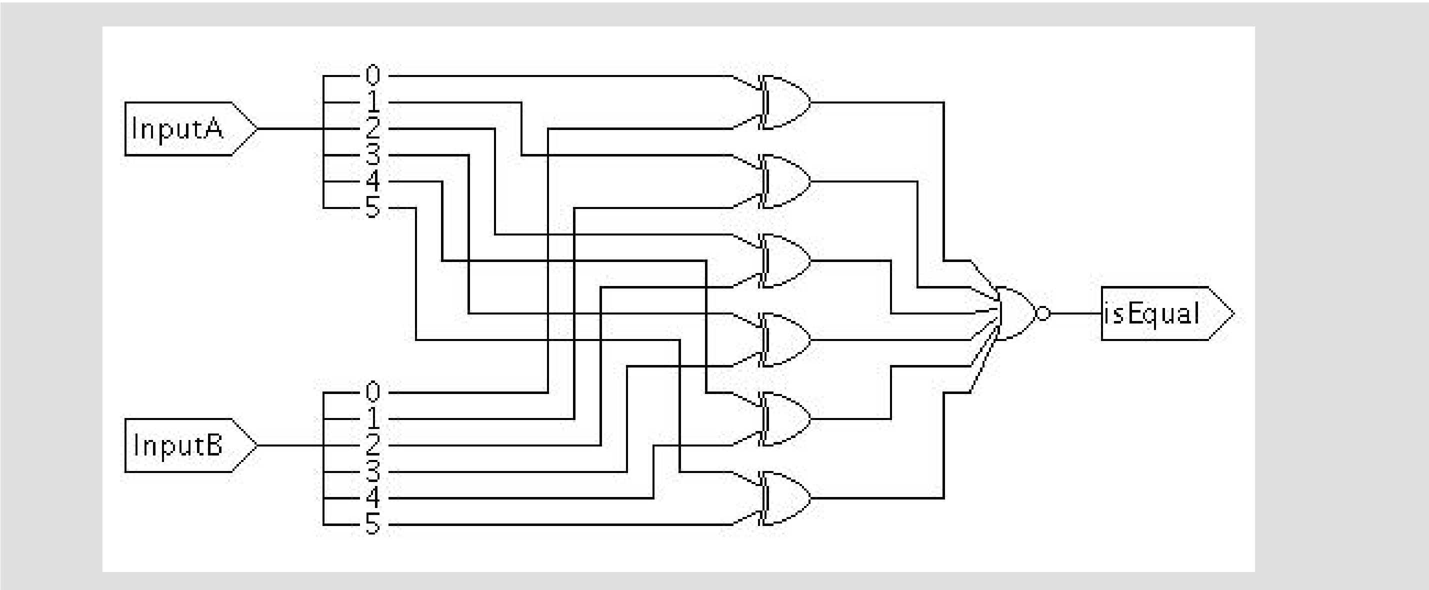
27. For this problem, you are going to design a circuit that controls one LED (you pick the LED) of a 7-LED digital *duodecimal* (i.e., base-12) display. For this problem, assume that inputs of 12 through 15 result in no LED being lit.



(a) Complete the truth table below:

A	B	C	D	state of LED
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

28. Design a circuit that takes two n-bit inputs and returns `true` if the two inputs are identical and `false` otherwise.


InputA
0
1
2
3
4
5
InputB
0
1
2
3
4
5
isEqual

29. Consider a rhinoceros that is on a diet. In general, the rhino will eat food that is tasty unless that food is high in fat. However, if the rhino is hungry, it will eat any food at all. Describe the behavior of the rhino using

    (a) a truth table

    (b) a Boolean expression

    (c) a circuit diagram