

# Warmup

Write the following binary numbers in decimal:

1100

101010

1111\_1111

Submit your answer on [pollev.com/stevenbell699](https://pollev.com/stevenbell699)

# ES 4: Number systems (and more VHDL)

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# By the end of class today, you should be able to:

- Convert between hexadecimal and binary
- Convert between 2's complement binary and decimal
- Explain why we prefer 2's complement to sign-magnitude
- Use the VHDL **process** structure for combinational logic and print-style debugging.

# Hexadecimal

Is just a shorthand for binary numbers

# Practice!

Write the following binary numbers in hex:

0101\_1010            1100\_0011            1011\_1110\_1110\_1111

Write these hexadecimal numbers in binary:

FF        80        DEAD

Submit binary->hex answers on **[pollev.com/stevenbell699](https://pollev.com/stevenbell699)**

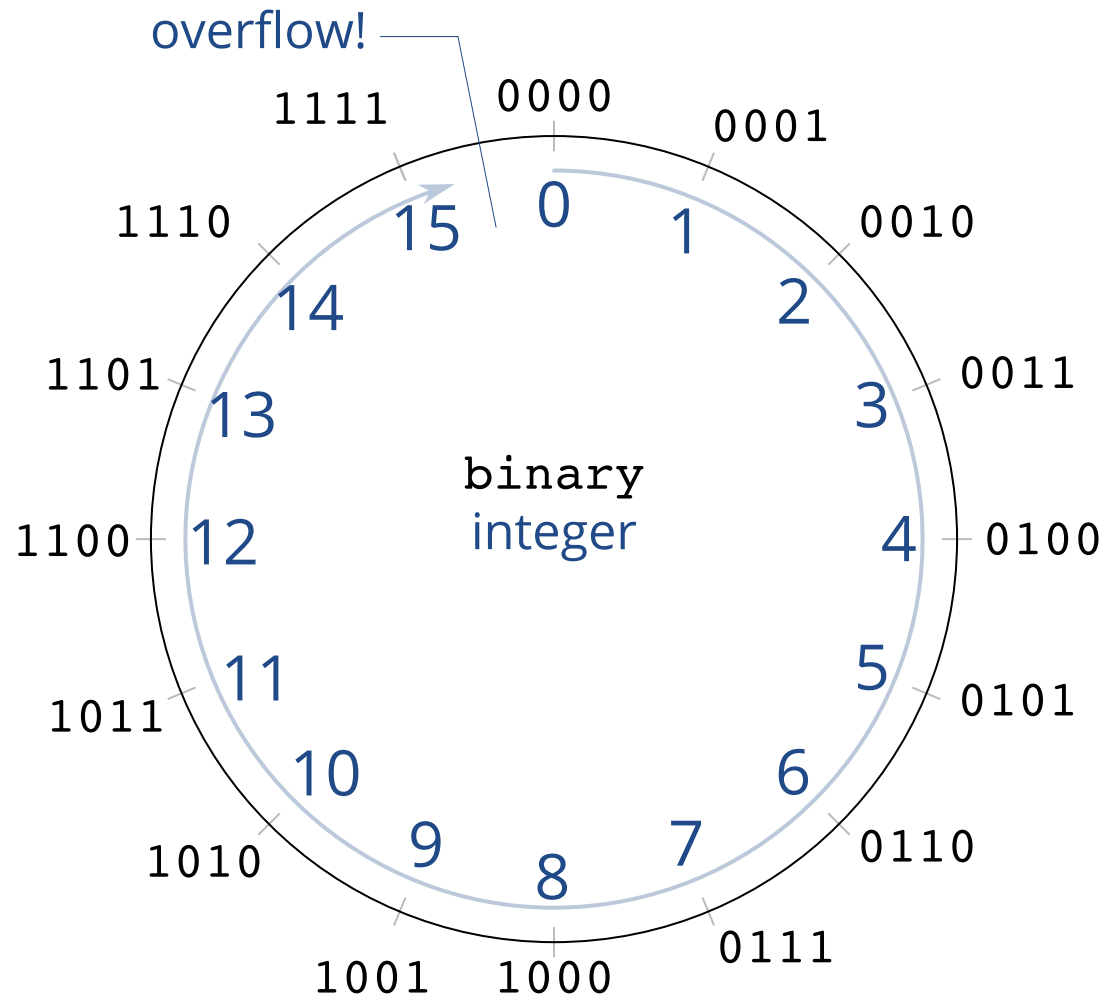
**10**

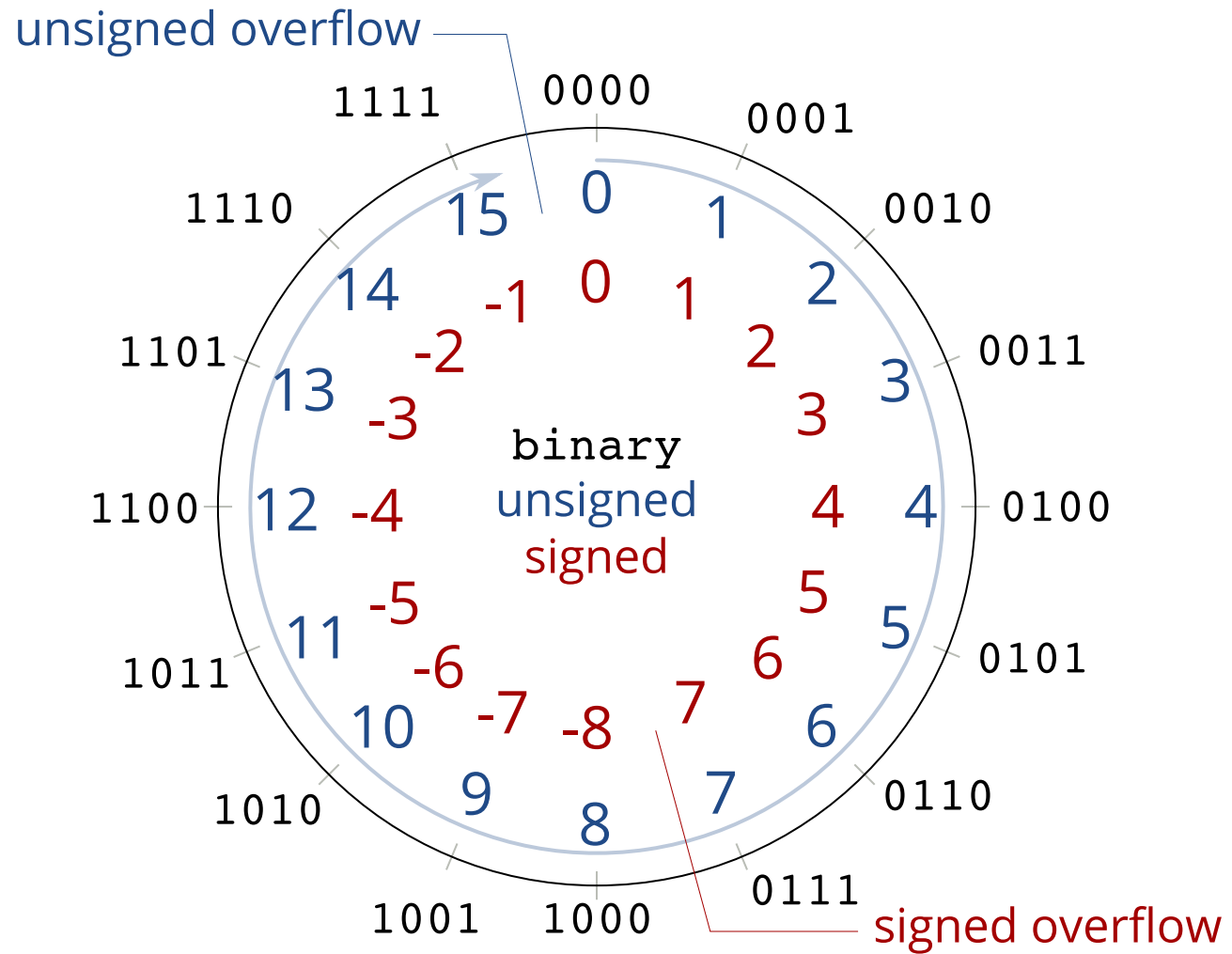
There are 10 kinds of people in the world.  
Those who understand binary,  
and those who don't.

There are  $\frac{10}{8}$  kinds of people in the world.

Those who understand hexadecimal,  
and those who don't.







To write a negative number in 2's complement:

**Write the positive number** in binary

**Flip all the bits** ( $1 \rightarrow 0$ ,  $0 \rightarrow 1$ )

**Add 1** (with all the appropriate carries)

To convert negative 2's complement to decimal,

**Flip all the bits** ( $1 \rightarrow 0$ ,  $0 \rightarrow 1$ )

**Add 1** (with all the appropriate carries)

Write the number in decimal

# Practice!

Write the following numbers in 8-bit 2's complement:

-16, -1, -127

Find the decimal value of these 2's complement numbers:

01001111, 11111110, 10000000

Submit your decimal answers on [\*\*pollev.com/stevenbell699\*\*](https://pollev.com/stevenbell699)

**Show and tell time**

# Printing stuff

```
variable l : line;
```

```
write(l, string("Hello, world!"));
```

```
writeline(output, l)
```

# Process block

```
process (SENSITIVITY) is  
begin  
  -- if/case/print go here  
end process;
```

# Practice!

<http://172.104.217.120:8000/>



# For Wednesday *(Monday is a holiday)*

1. Read the book (4.3, 4.9) and complete the pre-class quiz
2. Homework 3 is due next Wednesday (2/20) via **provide es4 hw3**
3. Lab report 2 due two weeks from today (2/27)