BINARY/HEXADECIMAL NUMBER CONVERSIONS

Bits: **B**inary Dig**its**

A bit is usually represented in a computer's main memory by a transistor that is switched on or off, or a capacitor that is charged or discharged.

Decimal Numbers (0-9)

- This is the numbering system we use in math everyday
- Aka Base 10

$10^4 = 10{,}000$	$10^3 = 1000$	$10^2 = 100$	$10^1 = 10$	$10^0 = 1$

- Each digit represent a base of 10 to some power
  - For example, $100 = 1 * 10^2 + 0 * 10^1 + 0 * 10^0$
  - Remember anything to the 0 power is 1
  - More examples (break down the following)
    - 1301, 2010, 58, 175

Binary Numbers (0s and 1s)

- These are the only numbers the computers understands
  - 1 means on
  - 0 means off
- Aka Base 2
- To convert a binary number to decimal:
- 10101101_2
- 10110101_2

Binary to Decimal

- To convert from Binary (base 2) to Decimal (base 10), use the following table:

2^9 512	2^8 256	2^7 128	2^6 64	2^5 32	2^4 16	2^3 8	2^2 4	2^1 2	2^0 1
							1	1	0

- Example: 110_2 convert to decimal (base 10)
- After filling in the table, do the following
- $1 * 4 + 1 * 2 + 0 * 1 = 6$
- Try these: 110101_2 or 11000011_2

Decimal to Binary

- To convert a decimal number to binary
  - Use the following table (where each row is a power of 2, starting with 0 on the right)

$2^7 =$	$2^6 =$	$2^5 =$	$2^4 =$	$2^3 =$	$2^2 =$	$2^1 =$	$2^0 =$
128	64	32	16	8	4	2	1

  - Take your initial number and find the largest base 2 number that can go into it, for example, let's use 52_{10}

Decimal to Binary

- Now try:
- Convert 7_{10}

- Convert 47_{10}

- Convert 222_{10}

Bits – 8 Bits = 1 byte

- One bit on its own can't represent much, so they are usually grouped together in groups of 8, which represent numbers from 0 to 255. A group of 8 bits is called a byte.
- The speed of a computer depends on the number of bits it can process at once. A 32 bit computer can process 32 bit numbers in one operation, while a 64 bit computer can process 64 bit numbers in one operation.

Questions

- What happens when a zero is placed on the left hand side of the number? What do we do in decimal?
- What happens when a zero is put on the right hand side of a binary number?
  - 111_2 versus 1110_2
- What is the pattern when all of the bits are turned on, for example, convert to binary and then discuss the pattern of:
- 1_2
- 11_2
- 111_2
- 1111_2
- 11111_2

Questions

- If each character on your keyboard represents 1 bit. How many bits does a computer need to store characters? How many total characters are on the keyboard?

- 7 bits are needed, but since computers work in groups of bytes (8 bits), we would use 8 bits with 1 bit wasted.

Hexadecimal Numbers (0-F)

- Hexadecimal Numbers were created to represent memory address in a more condensed form (rather than writing really long binary numbers).
- Aka Base 16 numbers using 0-9 and A-F
- The following table explains:

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Hexadecimal to Decimal

- If you have a hexadecimal number like DEB and need to convert it into a decimal number, you need to use the following table:

16^4 65, 536	16^3 4096	16^2 256	16^1 16	16^0 1
		D	E	B

- Now use multiplication
- D = 13, so 13 * 256 +
- E = 14, so 14 * 16 +
- B = 11, so 11 * 1
- 3328 + 224 + 11 = 3563
- Now try with these numbers $AF10_{16}$, $DD73_{16}$, $FFF25_{16}$

Decimal to Hexadecimal

- Whenever you are going from decimal you divide, and in this case you will divide by base 16 repeatedly by using the remainders.
- For example if you have 123_{10}

$16^3 = 4096$	$16^2 = 256$	$16^1 = 16$	$16^0 = 1$

- 123 falls between 256 and 16, so we will use the smaller number and divide, or 123/16 = 7 with a remainder of 11
- Since 11 represents B in hexadecimal numbers, your final answer would be 7B.
- Now try: 199_{10}, 220_{10}, 20_{10}, 8_{10}
- Or try 4100_{10}

Conversion summary

- How do you convert base 2 to base 10?
- How do you convert base 10 to base 2?
- How do you convert base 10 to base 16?
- How to you convert base 16 to base 10?
- How do you convert base 16 to base 2?
- How do you convert base2 to base ?
- Try: 1111_2 To $\_\_\_\_\_{}_{16}$
- Try: $F23_{16}$ To $\_\_\_\_\_{}_{2}$