Lecture 3

Binary

- For n binary digits, we can represent 2^n values
- Binary to Decimal:
  - Add up the powers of 2, e.g. $(1111)_2 = 2^3 + 2^2 + 2^1 + 2^0 = (15)_{10}$
- Decimal to Binary:
  - Divide the number by 2, and the remainder is the rightmost digit
  - e.g. $11/2 = 5R1$, $5/2 = 2R1$, $2/2 = 1R0$, $1/2 = 1R1$, so $(11)_{10} = (1011)_2$ (reading the remainders from right to left)

Hexadecimal:

- Hexadecimal to Binary:
  - Add up the powers of 16, similar to binary
- Decimal to Hexadecimal:
  - Either divide the number by 16 and keep the remainder as the rightmost digit (as in binary)
  - Or convert it to binary then conver every 4 binary digits to a hexadecimal digit (from the right)

Miscellaneous:

- Negative numbers will be covered later in the term
- Fractions: Either fixed point of floating point
  - Floating point: a number is represented as $1.100110... \times 2^{101\cdots}$, i.e. two signed binary numbers

Addition of binary numbers

- Exactly the same as decimal, but carry over happens at 2 instead of 10

Addition of hexadecimal numbers

- Exactly the same as decimal, but carry over happens at 16 instead of 10 *(note than the numbers 10-15 become A-F, they do not carry over!)*

Transistors as switches

- Transistors are the key technology to enable modern computers
- Moore's Laws: number of transistors manufactured on a chip doubles every 1.5 - 2 years
- Transistors operate as switches **in this class**
  - $x = 0$: Light is off
  - $x = 1$: Light is on
- Two or more transistors:
  - Series: AND

  - Parallel: OR
- NOT function: transistor and light bulb connected in parallel between voltage and ground