Analysis of Algorithms

Homework I

Due September 18^{th} 2025

1. (50 pts) We have the following code "Classic_Bit_Multiplication.c" which implements the old version of bit multiplication. Your task are two for this:

   (a) Implement the Gauss Trick, as you can see we have something quite simple when reaching the base case:

   ```
   if (n == 1){
     return a*b;
   }
   ```

   This uses the ALU for integer multiplication, but it can be substituted for something more efficient using xor because. For example, we can use xor for unsigned integer addition:

   ```
   unsigned int bitwise_add(unsigned int x, unsigned int y) {
       unsigned int carry;
       while (y != 0) {
           carry = x & y;
           x = x ^ y;
           y = carry << 1;
           }
           return x;
   }
   ```

   (b) Please compare the time complexity between both implementations by using the "sys/-time.h" using gettimeofday() for higher precision.

2. (50 Points) Give asymptotic upper and lower bounds for $T(n)$ in:

   (a) $T(n) = T(n-1) + n^c$,where $c \geq 1$ is a constant.

   (b) $T(n) = T(\sqrt{n}) + 1$.

   (c) $T(n) = 5T\left(\frac{n}{2}\right) + \frac{n}{\log n}$.