1 Bit Manipulation

1. Write 22 in binary.

2. Assuming \(x_1, x_2, ..., x_n\) are integers. What is \((x_1 \land x_2 \land ... \land x_n)^\land (x_1 \land x_2 \land ... \land x_n)\)?

3. Write an expression to check whether a 32-bit integer is less than 0 using only == and the bit operators.

4. What does the following code do?
   ```java
   public static int mysteryBit(int n) {
       return n & (n - 1);
   }
   ```

5. Write a program to count the number of 1 bits in an integer. You can use the function in part 5 as a hint.
   ```java
   public static int countBits(int n) {
   }
   ```

2 Algorithmic Analysis

1. For each of the following function, find the Big-Theta expression for:
   a) The number of \(i += 1\) or \(i *= 2\) operations
   b) The number of \(j += 1\) operations
   c) The number of print operations
   d) The runtime of the function
   ```java
   public static void printIndices(int n) {
       for (int i = 0; i < n; i += 1) {
           for (int j = 0; j < i; j += 1) {
               System.out.println(i + j);
           }
       }
   }
   ```
   ```java
   public static void printIndices2(int n) {
       for (int i = 1; i < n; i *= 2) {
           for (int j = 0; j < i; j += 1) {
               System.out.println(j);
           }
       }
   }
   ```
2. What is the big-Theta running time of the following functions?

```java
public int weirdFib(int n) {
    if (n <= 1) {
        return n;
    }
    return weirdFib(n - 1) + weirdFib(n - 1);
}

public static void mystery(int n) {
    if (n == 1) {
        return;
    }
    for (int i = 0; i < n; i += 1) {
        mystery(n-1);
    }
}
```

3. Regex

Write a Java regular expression to match each of the following sets of binary strings. You may only use the following characters: ()|01*

1) All binary strings
2) Binary strings that begins and ends with 1
3) Binary strings that contains at least three 1s
4) Binary string that contains at least three consecutive 1s
5) Binary string that doesn’t contain the substring 110.