1  Bit Manipulation

1. Write 22 in binary.

2. Assuming $x_1, x_2, ..., x_n$ are integers. What is $\left( x_1 \lor x_2 \lor ... \lor x_n \right) \land \left( x_1 \lor x_2 \lor ... \lor x_n \right)$?

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.