Problem 1. [Category: Proof] Prove that each of the following languages is not regular.

1. \( \{0^{2n}1^n \mid n \geq 0\} \)

2. Binary palindromes: Strings over \( \{0, 1\} \) that are equal to their reversals. For example: 00111100 and 0100010, but not 01100.

3. \( \{0^m1^n \mid m \neq 2n\} \)

4. Strings over \( \{0, 1\} \) where the number of 0s is exactly twice the number of 1s.

5. Strings of properly nested parentheses (), brackets [], and braces {}. For example, the string ([]){} is in this language, but the string ([]) is not, because the left and right delimiters don’t match.

6. \( \{0^{2^n} \mid n \geq 0\} \) Strings of 0s whose length is a power of 2.

7. Strings of the form \( w_1#w_2#\cdots#w_n \) for some \( n \geq 2 \), where each substring \( w_i \) is a string in \( \{0, 1\}^* \), and some pair of substrings \( w_i \) and \( w_j \) are equal.