Prove that each of the following languages is not regular.

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

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

3. \( \{ 0^n 1^m \mid m \neq 2n \} \)

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

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. 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.

Work on these later:

7. \( \{ 0^n \mid n \geq 0 \} \)

8. \( \{ w \in (0 + 1)^* \mid w \text{ is the binary representation of a perfect square} \} \)