1. Find the limit inferior and limit superior of the following sequences
   a) \( \left\{ \frac{2 - (-1)^n n}{4n + 2} \right\} \).
   b) \( \left\{ 0.9 + \sin \left( \frac{n\pi}{2} \right) \right\} \).
   c) \( \sqrt[2n]{\frac{(n!)^2}{(2n)!}} \). (Hint: Use Exercise 8.2 in the lecture notes.)

2. Let \( \{a_n\} \) be a bounded sequence of real numbers. Show that
   \[ \limsup_{n \to \infty} \sqrt{|a_n|} = \sqrt{\limsup_{n \to \infty} |a_n|}. \]

3. Let \( \{a_n\} \) and \( \{b_n\} \) be Cauchy sequences. Show that \( \{a_n + b_n\} \) and \( \{a_n b_n\} \) are also Cauchy sequences.

4. For each of the following series, calculate the \( n \)-th partial sum \( S_n \), and determine whether the series is convergent or divergent.
   i) \( \sum_{n=1}^{\infty} \ln \frac{n + 2}{n + 3} \).
   ii) \( \sum_{n=1}^{\infty} \frac{1}{n(n + 2)} \).