Problem 1 (10 pts) Solve the differential equation
\[(x^2 + 1)y' + yx = x^2e^x \sqrt{x^2 + 1}\]

Problem 2 (10 pts) Find the sum of the series.
\[\sum_{n=3}^{\infty} \frac{-2}{n^2 - 1}\]

Problem 3 (10 pts) Find all values of the parameter \(p\) for which the following series converges. Full justification is required.
\[\sum \frac{1}{(n^2 + 1)^p}\]

Problem 4 (10 pts) Determine whether or not the series converges. Indicate all tests/theorems used and explain why they can be used.
\[\sum \frac{1}{n \ln n \sqrt{\ln \ln n}}\]

Problem 5 (10 pts) Solve the differential equation.
\[y'' - 4y = x + 2\]

Problem 6 (10 pts) Find the area of the region between the outer loop and the inner loop of the curve \(r = 1 + 2 \sin \theta\).

Problem 7 (10 pts) Find the limit of the sequence or show that it diverges.
\[\left\{ \sqrt{n^2 + 1} - \sqrt{n^2 + n} \right\}\]

Problem 8 (10 pts) Determine whether or not the series converges. Indicate all tests/theorems used and explain why they can be used.
\[\sum \frac{n!}{n^n}\]
Problem 9 (10 pts) Determine whether or not the series converges. Indicate all tests/theorems used and explain why they can be used.

\[ \sum \frac{\sin n}{n^5} \]

Problem 10 (10 pts) Solve the differential equation.

\[ y'' - 4y' + 4y = 0 \]