1. If \( f(x) = (x - 1)^4(x - 2)^3(x - 3)^2 \), find \( f''''(1) + f'''(2) + f''(3) \).

2. Evaluate the integral
\[
\int_0^\pi \frac{dx}{1 + (\tan x)^\pi}.
\]

3. What is the minimal distance between the curves \( y = e^x \) and \( y = \ln x \)?

4. Let \( f \) be one of the solutions to the differential equation
\[
f''(x) - 2xf'(x) - 2f(x) = 0.
\]
Supposing that \( f \) has Taylor expansion
\[
f(x) = 1 + x + ax^2 + bx^3 + cx^4 + dx^5 + \cdots
\]

near the origin, find \((a, b, c, d)\).

5. How many real zeroes does the function \( f(x) = \frac{x^{2011}}{2011} + \frac{x^{2010}}{2010} + \cdots + x + 1 \) have?

6. Find the maximum value of \( a \) and minimum value of \( b \) such that \( a \leq \arctan \frac{x}{2} \leq b \) for \( 0 \leq x \leq 1 \).
Express your answer as an ordered pair \((a, b)\).

7. For the curve \( \sin(x) + \sin(y) = 1 \) lying on the first quadrant, find the constant \( \alpha \) such that
\[
\lim_{x \to 0} x^\alpha \frac{d^2y}{dx^2}
\]
exists and is nonzero.

8. Find the volume of the intersection of 3 cylinders that lie in the plane, each of radius 1 and with an angle between each pair of cylindrical axes of \( \pi/3 \).

9. Three numbers are chosen at random between 0 and 2. What is the probability that the difference between the greatest and least is less than \( \frac{1}{4} \)?

10. Evaluate the integral
\[
\int_0^\pi \ln(1 - 2a \cos x + a^2) \, dx
\]
for \( a > 1 \).