Problem 1. (12%) Find \( \lim_{x \to 1^-} \left( \frac{\pi}{2} - \arcsin x \right)^{\arctan \frac{\sqrt{1-x^2}}{x}} \).

Problem 2. (12%) Find \( \frac{d}{dx} \int_{\arccos x}^{\exp(x^2)} \frac{u^2}{4 + u^4} \, du \) for \(-1 < x < 1\).

Problem 3. (12%) Evaluate \( \int_0^1 x^2 \arctan x \, dx \) using integration by parts with \( u = x^2 \) and \( dv = \arctan x \, dx \).

Problem 4. (12%) Find the indefinite integral \( \int \frac{dx}{x^n(x-1)} \), where \( n \) is a positive integer.

Problem 5. (12%) Evaluate \( \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{dx}{3 + 2 \cos(4x)} \).

Problem 6. (10%) Find the Maclaurin series of the function \( y = \frac{\arctan x}{1-x} \). Note that you need to specify the interval of convergence of the Maclaurin series.

Problem 7. (10%) Find the maximum of \( x^2 + y^2 + z^2 \) subject to the constraints \( x - y - 1 = y^2 - z^2 = 0 \).

Problem 8. (10%) Let \( T \) be the trapezoid with vertices (1, 1), (2, 2), (2, 0) and (4, 0). Evaluate the double integral \( \iint_T e^{(y-x)/(y+x)} \, dA \) by transforming to polar coordinates.

Problem 9. (10%) Let \( C \) be the polar curve with polar representation \( r = \cos 3\theta \), \( 0 \leq \theta \leq \pi \) (see the Figure below).

\[ \text{Find the area enclosed by the curve.} \]