1. 30 pts Compute the contour integral

\[ \int_C \frac{dz}{z(z-2)} \]

where \( C = \{ |z-2| = 1 \} \)
2.30 pts Is the function $f(z) = e^z (x^2 + iy^2)$ differentiable at $z = 0$? Is it analytic at $z = 0$?
3.30 pts Find the region of convergence of the series

\[ \sum_{n=1}^{\infty} \ln\left(1 + \frac{1}{n(n+1)}\right)z^n \]
4.30 pts Is the function

\[ g(z) = \begin{cases} \frac{\sin(z)}{z(z - \pi)}, & z \neq \pi, |z - \pi| < \frac{\pi}{2} \\ \frac{1}{\pi}, & z = \pi \end{cases} \]

analytic in \(|z - \pi| < \frac{\pi}{2}\)? Is it entire?
5.30 pts Compute the integral

$$\int_C \frac{dz}{(\cos z)^2}$$

where $C$ is: