(1) Find where
\[
\tan^{-1}(z) = \frac{i}{2} \log \frac{i + z}{i - z}
\]
is analytic?

(2) Show that
\[
|\log(z)| \leq |\ln |z|| + \pi
\]
for all \( z \neq 0 \).

(3) Evaluate the following integrals:
   (a) \( \int_{1}^{2} \left( t^2 + i \right)^2 dt \);
   (b) \( \int_{0}^{\pi/4} e^{-2it} dt \);
   (c) \( \int_{0}^{\infty} te^{zt} dt \) when \( \text{Re}(z) < 0 \).

(4) Find the contour integral \( \int_{\gamma} f(z) dz \) for
   (a) \( \gamma \) is the triangle \( ABC \) oriented counterclockwise, where
       \( A = 0, B = 1 + i \) and \( C = -2 \);
   (b) \( \gamma \) is the circle \( |z - i| = 2 \) oriented counterclockwise.

(5) Evaluate the contour integral
\[
\int_{C} f(z) dz
\]
using the parametric representations for \( C \), where
\[
f(z) = \frac{z^2 - 1}{z}
\]
and the curve \( C \) is
   (a) the semicircle \( z = 2e^{i\theta} \) (0 \( \leq \theta \leq \pi \));
   (b) the semicircle \( z = 2e^{i\theta} \) (\( \pi \leq \theta \leq 2\pi \));
   (c) the circle \( z = 2e^{i\theta} \) (0 \( \leq \theta \leq 2\pi \)).

(6) Redo (5) using an anti-derivative of \( f(z) \).
(7) Let \( C_R \) be the circle \(|z| = R\) \((R > 1)\) oriented counterclockwise. Show that

\[ \left| \int_{C_R} \frac{\text{Log}(z^2)}{z^2} dz \right| < 4\pi \left( \frac{\pi + \ln R}{R} \right) \]

and then

\[ \lim_{R \to \infty} \int_{C_R} \frac{\text{Log}(z^2)}{z^2} dz = 0. \]

(8) Without evaluating the integral, show that

\[ \left| \int_C \frac{dz}{z^2 + z + 1} \right| \leq \frac{9\pi}{16} \]

where \( C \) is the arc of the circle \(|z| = 3\) from \( z = 3 \) to \( z = 3i \) lying in the first quadrant.