1. Find all eigenvalues and eigenvectors of the matrix

\[
\begin{bmatrix}
1 & 1 \\
1 & 1
\end{bmatrix}.
\]

(You do not have to normalize eigenvectors.)

2. Show that the vector field

\[
\mathbf{u} := \begin{bmatrix} x \\ y \\ -2z \end{bmatrix}
\]

has zero curl, and find a scalar function \( \phi \) such that

\[\mathbf{u} = \nabla \phi.\]

3. Determine whether the function \( f(x + iy) := xy^2 + i(x + y)^3 \) is analytic in \( \mathbb{C} \).

4. Evaluate the integral

\[
\int_0^{2\pi} \frac{1 + \cos \theta}{2 - \sin \theta} d\theta.
\]