1. Show that $f'(z)$ doesn’t exist at any point if $f(z) = z + \bar{z}$.

2. Determine when $f'(z)$ exists if $f(z) = z \text{Re}(z)$, where $\text{Re}(z)$ denotes the real part of $z$.

3. Prove that $f(z) = (3x + y) + i(3y - x)$ is entire.

4. (i). $z = x + yi \in \mathbb{C}$, prove $x = \frac{z + \bar{z}}{2}$ and $y = \frac{z - \bar{z}}{2i}$.

   (ii). We define $\frac{\partial}{\partial z} = \frac{1}{2}(\frac{\partial}{\partial x} + i\frac{\partial}{\partial y})$. Prove if $f'(z)$ exists, then $\frac{\partial f}{\partial \bar{z}} = 0$.

5. Derive the polar form of Cauchy-Riemann Equations. (Recall that $x = r \cos \theta$ and $y = r \sin \theta$).

6. Derive the polar form of Laplace’s equation $u_{xx} + u_{yy} = 0$.

7. If $u(x, y)$ is a harmonic function on a domain $D$, we say $v(x, y)$ is a harmonic conjugate of $u(x, y)$ if the complex function $f(z) = u(x, y) + v(x, y)i$ has derivative. Prove that if $v(x, y)$ and $w(x, y)$ are both harmonic conjugates of $u(x, y)$ on $D$, then $v(x, y)$ and $w(x, y)$ are differed by a constant.