**1.** Compute the integrals

$$(a) \int_1^2 \left(\frac{1}{t} - i\right)^2 dt, \ (b) \int_0^{\pi/6} e^{2it}\, dt, \ (c) \int_0^{\infty} e^{-zt}\, dt \ (\mathrm{Re}\, z > 0).$$

**2.** Compute the integral $\forall m, n \in \mathbb{Z}$:

$$\frac{1}{2\pi} \int_0^{2\pi} e^{imt} \overline{e^{int}}\, dt.$$

**3.** Find a differentiable function $f : [0,1] \to \mathbb{C}$ such that for no $\xi \in [0,1]$ it is true that

$$f'(\xi) = f(1) - f(0).$$

In this way you have shown that the mean value theorem fails for complex valued functions.

**4.** If $\Gamma$ is the upper half of the unit circle $\{|z| = 1\}$ (oriented from left to right) compute the contour integral

$$\oint_\Gamma 1 + z^2\, dz.$$

**5.** If $\Gamma$ is the line segment from 1 to $i$ compute the contour integral

$$\oint_\Gamma e^z\, dz.$$

**6.** If $\Gamma$ is the line segment from 1 to 0 followed by the line segment from 0 to $i$ find a parametrization of the curve $\Gamma$. Then compute the contour integral

$$\oint_\Gamma z^3\, dz.$$