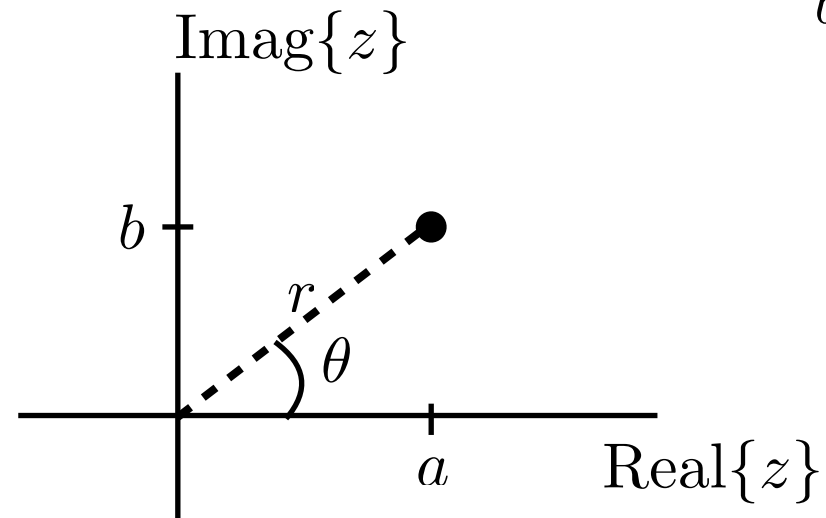# Complex Numbers

$$j = \sqrt{-1}$$

$$z = a + jb = re^{j\theta} \qquad a = r\cos(\theta) \qquad z^* = a - jb = re^{-j\theta}$$

$$b = r\sin(\theta)$$

$$\cos(\theta) = \frac{e^{j\theta} + e^{-j\theta}}{2}$$

$$\sin(\theta) = \frac{e^{j\theta} - e^{-j\theta}}{2j}$$

Spectrum shows signal content as a function of frequency

$$
\begin{aligned}
x(t) &= A\cos(2\pi f_o t + \phi) \\
&= \frac{Ae^{j\phi}}{2}e^{j2\pi f_o t} + \frac{Ae^{-j\phi}}{2}e^{-j2\pi f_o t}
\end{aligned}
$$