# Complex Numbers:

Multiply - expand

Divide - multiple top and bottom by conjugate

If polynomial has only real coefficients, then roots occur in conjugate pairs.

Conjugate - reflect in real axis

Polar Multiplication - $r_1 r_2 [\cos(\theta_1 + \theta_2) + j\sin(\theta_1 + \theta_2)]$

Division - divide r's, subtract angles

$$[r(\cos\theta + j\sin\theta)]^n = r^n[\cos(n\theta) + j\sin(n\theta)]$$

$$x + jy = r(\cos\theta + j\sin\theta) = re^{j\theta}$$

$$\ln z = \ln|z| + j(\arg z + 2n\pi)$$

$$\cos^n\theta = \left[\frac{1}{2}(e^{j\theta} + e^{-j\theta})\right]^n, \quad \sin^n\theta = \left[\frac{1}{2j}(e^{j\theta} - e^{-j\theta})\right]^n$$

$$\cos jx = \cosh x, \quad \sin jx = j\sinh x$$

$$z^n + z^{-n} = 2\cos n\theta, \quad z^n - z^{-n} = 2j\sin n\theta$$

Binomial Theorem:

$$(a+b)^n = \sum_{K=0}^{n} \binom{n}{K} a^{n-K} b^K \ldots \qquad K = 0 \rightarrow n$$