$$
\begin{aligned}
\sin(-\theta) &= -\sin(\theta) \\
\cos(-\theta) &= \cos(\theta) \\
\\
\sin(A+B) &= \sin(A)\cos(B) + \cos(A)\sin(B) \\
\cos(A+B) &= \cos(A)\cos(B) - \sin(A)\sin(B) \\
\\
\sin^2(\theta) &= \frac{1-\cos(2\theta)}{2} \\
\cos^2(\theta) &= \frac{1+\cos(2\theta)}{2} \\
\\
\sin(A)\sin(B) &= \frac{\cos(A-B) - \cos(A+B)}{2} \\
\cos(A)\cos(B) &= \frac{\cos(A+B) + \cos(A-B)}{2} \\
\\
\sin(A)\cos(B) &= \frac{\sin(A+B) + \sin(A-B)}{2} \\
\cos(A)\sin(B) &= \frac{\sin(A+B) - \sin(A-B)}{2} \\
\\
\sin(A) + \sin(B) &= 2\sin\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right) \\
\cos(A) + \cos(B) &= -2\cos\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)
\end{aligned}
$$

$$
\begin{aligned}
j &\triangleq \sqrt{-1} \\
z &\triangleq x + jy \triangleq re^{j\theta} \\
\\
x &= r\cos(\theta) \\
y &= r\sin(\theta) \\
\\
r &= |z| = \sqrt{x^2+y^2} \\
\theta &= \angle z = \tan^{-1}(y/x) \\
\\
|z_1 z_2| &= |z_1|\,|z_2| \\
|z_1/z_2| &= |z_1|\,/\,|z_2| \\
\\
|e^{j\theta}| &= 1 \\
\angle r &= 0 \\
\\
z_1 z_2 &= (x_1x_2 - y_1y_2) + j(x_1y_2 + x_2y_1) \\
z_1 z_2 &= r_1 r_2 e^{j(\theta_1+\theta_2)} \\
\\
\overline{z} &\triangleq x - jy = re^{-j\theta} \\
z\overline{z} &= |z|^2 = x^2 + y^2 = r^2
\end{aligned}
$$

$$
\sin x = \frac{e^{ix} - e^{-ix}}{2i}
$$

$$
\cos x = \frac{e^{ix} + e^{-ix}}{2}
$$

DTFT Cheat Sheet (Courtesy of Signals and Systems by Alkin, page 461-462)

Name	Signal	Transform
Discrete-time pulse	$x[n] = \begin{cases} 1\,, & \lvert n\rvert \le L \\ 0 & \text{otherwise} \end{cases}$	$X(\Omega) = \dfrac{\sin\left(\dfrac{(2L+1)\,\Omega}{2}\right)}{\sin\left(\dfrac{\Omega}{2}\right)}$
Unit-impulse signal	$x[n] = \delta[n]$	$X(\Omega) = 1$
Constant-amplitude signal	$x[n] = 1\,,\ \text{all}\ n$	$X(\Omega) = 2\pi \sum_{m=-\infty}^{\infty} \delta(\Omega - 2\pi m)$
Sinc function	$x[n] = \dfrac{\Omega_c}{\pi}\, \text{sinc}\left(\dfrac{\Omega_c n}{\pi}\right)$	$X(\Omega) = \begin{cases} 1\,, & \lvert\Omega\rvert < \Omega_c \\ 0\,, & \text{otherwise} \end{cases}$
Right-sided exponential	$x[n] = \alpha^n\, u[n]\,,\ \ \lvert\alpha\rvert < 1$	$X(\Omega) = \dfrac{1}{1 - \alpha\, e^{-j\Omega}}$
Complex exponential	$x[n] = e^{j\Omega_0 n}$	$X(\Omega) = 2\pi \sum_{m=-\infty}^{\infty} \delta(\Omega - \Omega_0 - 2\pi m)$

Table 5.4 – Some DTFT transform pairs.

Theorem	Signal	Transform	
Linearity	$\alpha\, x_1[n] + \beta\, x_2[n]$	$\alpha\, X_1(\Omega) + \beta\, X_2(\Omega)$	
Periodicity	$x[n]$	$X(\Omega) = X(\Omega + 2\pi r)$	for all integers r
Conjugate symmetry	$x[n]$ real	$X^*(\Omega) = X(-\Omega)$	
		Magnitude:	$\lvert X(-\Omega)\rvert = \lvert X(\Omega)\rvert$
		Phase:	$\Theta(-\Omega) = -\Theta(\Omega)$
		Real part:	$X_r(-\Omega) = X_r(\Omega)$
		Imaginary part:	$X_i(-\Omega) = -X_i(\Omega)$
Conjugate antisymmetry	$x[n]$ imaginary	$X^*(\Omega) = -X(-\Omega)$	
		Magnitude:	$\lvert X(-\Omega)\rvert = \lvert X(\Omega)\rvert$
		Phase:	$\Theta(-\Omega) = -\Theta(\Omega) \mp \pi$
		Real part:	$X_r(-\Omega) = -X_r(\Omega)$
		Imaginary part:	$X_i(-\Omega) = X_i(\Omega)$
Even signal	$x[n] = x[-n]$	$\text{Im}\{X(\Omega)\} = 0$	
Odd signal	$x[n] = -x[-n]$	$\text{Re}\{X(\Omega)\} = 0$	
Time shifting	$x[n-m]$	$X(\Omega)\, e^{-j\Omega m}$	
Time reversal	$x[-n]$	$X(-\Omega)$	
Conjugation	$x^*[n]$	$X^*(-\Omega)$	
Frequency shifting	$x[n]\, e^{j\Omega_0 n}$	$X(\Omega - \Omega_0)$	
Modulation	$x[n]\, \cos(\Omega_0 n)$	$\frac{1}{2}\left[X(\Omega - \Omega_0) + X(\Omega + \Omega_0)\right]$	
	$x[n]\, \sin(\Omega_0 n)$	$\frac{1}{2}\left[X(\Omega - \Omega_0)\, e^{-j\pi/2} + X(\Omega + \Omega_0)\, e^{j\pi/2}\right]$	
Differentiation in frequency	$n^m\, x[n]$	$j^m \dfrac{d^m}{d\Omega^m}\left[X(\Omega)\right]$	
Convolution	$x_1[n] * x_2[n]$	$X_1(\Omega)\, X_2(\Omega)$	
Multiplication	$x_1[n]\, x_2[n]$	$\dfrac{1}{2\pi}\displaystyle\int_{-\pi}^{\pi} X_1(\lambda)\, X_2(\Omega - \lambda)\, d\lambda$	
Parseval's theorem	$\displaystyle\sum_{n=-\infty}^{\infty} \lvert x[n]\rvert^2 = \dfrac{1}{2\pi}\int_{-\pi}^{\pi} \lvert X(\Omega)\rvert^2\, d\Omega$		

Table 5.3 – DTFT properties.

Table 8-2 Basic discrete Fourier transform properties.

Table of DFT Properties		
Property Name	***Time-Domain: $x[n]$***	***Frequency-Domain: $X[k]$***
Periodic	$x[n] = x[n+N]$	$X[k] = X[k+N]$
Linearity	$ax_1[n] + bx_2[n]$	$aX_1[k] + bX_2[k]$
Conjugate Symmetry	$x[n]$ is real	$X[N-k] = X^*[k]$
Conjugation	$x^*[n]$	$X^*[N-k]$
Time-Reversal	$x[((N-n))_N]$	$X[N-k]$
Delay	$x[((n-n_d))_N]$	$e^{-j(2\pi k/N)n_d} X[k]$
Frequency Shift	$x[n]e^{j(2\pi k_0/N)n}$	$X[k-k_0]$
Modulation	$x[n]\cos((2\pi k_0/N)n)$	$\frac{1}{2}X[k-k_0] + \frac{1}{2}X[k+k_0]$
Convolution	$\sum_{m=0}^{N-1} h[m]x[((n-m))_N]$	$H[k]X[k]$
Parseval's Theorem	$\sum_{n=0}^{N-1} \lvert x[n]\rvert^2 = \frac{1}{N}\sum_{k=0}^{N-1} \lvert X[k]\rvert^2$	

Table of DFT Pairs	
Time-Domain: $x[n]$	***Frequency-Domain: $X[k]$***
$\delta[n]$	1
$\delta[n-n_d]$	$e^{-j(2\pi k/N)n_d}$
$r_L[n] = u[n] - u[n-L]$	$\underbrace{\frac{\sin(\frac{1}{2}L(2\pi k/N))}{\sin(\frac{1}{2}(2\pi k/N))}}_{=D_L(2\pi k/N)} e^{-j(2\pi k/N)(L-1)/2}$
$r_L[n]\, e^{j(2\pi k_0/N)n}$	$D_L(2\pi(k-k_0)/N)\, e^{-j(2\pi(k-k_0)/N)(L-1)/2}$

TABLE 10.2 SOME COMMON z-TRANSFORM PAIRS

Signal	Transform	ROC
1. $\delta[n]$	1	All z
2. $u[n]$	$\frac{1}{1-z^{-1}}$	$\lvert z\rvert > 1$
3. $-u[-n-1]$	$\frac{1}{1-z^{-1}}$	$\lvert z\rvert < 1$
4. $\delta[n-m]$	z^{-m}	All z, except 0 (if $m>0$) or ∞ (if $m<0$)
5. $\alpha^n u[n]$	$\frac{1}{1-\alpha z^{-1}}$	$\lvert z\rvert > \lvert\alpha\rvert$
6. $-\alpha^n u[-n-1]$	$\frac{1}{1-\alpha z^{-1}}$	$\lvert z\rvert < \lvert\alpha\rvert$
7. $n\alpha^n u[n]$	$\frac{\alpha z^{-1}}{(1-\alpha z^{-1})^2}$	$\lvert z\rvert > \lvert\alpha\rvert$
8. $-n\alpha^n u[-n-1]$	$\frac{\alpha z^{-1}}{(1-\alpha z^{-1})^2}$	$\lvert z\rvert < \lvert\alpha\rvert$
9. $[\cos\omega_0 n]u[n]$	$\frac{1-[\cos\omega_0]z^{-1}}{1-[2\cos\omega_0]z^{-1}+z^{-2}}$	$\lvert z\rvert > 1$
10. $[\sin\omega_0 n]u[n]$	$\frac{[\sin\omega_0]z^{-1}}{1-[2\cos\omega_0]z^{-1}+z^{-2}}$	$\lvert z\rvert > 1$
11. $[r^n\cos\omega_0 n]u[n]$	$\frac{1-[r\cos\omega_0]z^{-1}}{1-[2r\cos\omega_0]z^{-1}+r^2z^{-2}}$	$\lvert z\rvert > r$
12. $[r^n\sin\omega_0 n]u[n]$	$\frac{[r\sin\omega_0]z^{-1}}{1-[2r\cos\omega_0]z^{-1}+r^2z^{-2}}$	$\lvert z\rvert > r$

Property	**Time Domain**	**z- Domain**	**Region of Convergence**
Notation	$h[n]$	$H[z]$	R_h
	$g[n]$	$G[z]$	R_g
Linearity	$\alpha h[n]+bg[n]$	$\alpha H[z]+bG[z]$	At least $R_h \cap R_g$
Time shifting	$h[n-n_0]$	$z^{-n_0}H(z)$	R_h ,except z=0 if $n_0>0$ and z=0 if $n_0<0$
Time reversal	$h[-n]$	$H(z^{-1})$	$1/R_h$
Convolution	$h[n]*g[n]$	$H[z]G[z]$	At least $R_h \cap R_g$