## BODE PLOT - S-PLANE REVIEW

	NONINVERTING DC GAIN	INVERTING DC GAIN	
TERM IN H(s)	+K	-K	
S-PLANE	Δ jω σ	σ	
	(NOT VISIBLE IN S-PLANE)	(NOT VISIBLE IN S-PLANE)	
BODE PLOT:	+K =K	$\left -K\right =K$	
LET s = jω	H  <b>▲</b> [dB]	H  <b>▲</b> [dB]	
MAGNITUDE	20log(K) ω	20log(K) ω	
PHASE	(deg) 0° ω	<u>/H</u> [deg] ω -180°	
	$\frac{K}{K} = \tan^{-1}(0/K) = 0$	$\frac{1}{\sqrt{-K}} = \tan^{-1}(0/-K) = -180$	

	LHP ZERO	ZERO AT ORIGIN (DERIVATIVE)	RHP ZERO
TERM IN H(s)	$1 + s\tau_{ZL}$	$s au_{ZO}$	$1-s au_{ZR}$
S-PLANE	$ \begin{array}{c c}  & j\omega \\ \hline  & -1 \\ \hline  & \tau_{ZL} \end{array} $	σ	$ \begin{array}{c}                                     $
BODE PLOT:	$\left 1+j\omega\tau_{ZL}\right  = \sqrt{1^2 + \left(\omega\tau_{ZL}\right)^2}$	$ 0+j\omega\tau_{ZO} =\omega\tau_{ZO}$	$\left 1 - j\omega\tau_{ZR}\right  = \sqrt{1^2 + \left(\omega\tau_{ZR}\right)^2}$
LET s = jω	H  <b>↑</b> +20dB/dec	H  +20dB/dec [dB]	H  <b>↑</b> +20dB/dec [dB]
MAGNITUDE	<u>1</u>	<u>1</u>	<u>1</u>
PHASE	$ au_{ZL}$ $\begin{array}{c} \frac{/\mathrm{H}}{(\mathrm{deg}]} \\ +90^{\circ} \\ +45^{\circ} \end{array}$	$\tau_{ZO}$ $\begin{array}{c} (\omega \tau_{ZO}) \\ (\omega \tau_{ZO}) \end{array}$	τ <sub>ZR</sub> [deg]  -45° -90°
		$\sqrt{0 + j\omega\tau_{ZL}} = \tan^{-1}\left(\frac{\omega\tau_{ZL}}{0}\right) = +90^{\circ}$	$\sqrt{1-j\omega\tau_{ZR}} = \tan^{-1}(-\omega\tau_{ZR})$

	LHP POLE	POLE AT ORIGIN (INTEGRATOR)	RHP POLE
TERM IN H(s)	$\frac{1}{1+s au_{PL}}$	1	$\frac{1}{1-s\tau_{PR}}$
S-PLANE	$\begin{array}{c c}  & \downarrow & \downarrow & \downarrow \\  & \downarrow & \downarrow & \downarrow \\  & \downarrow & \downarrow & \downarrow \\  & & \downarrow & \downarrow \\  & & \downarrow & \downarrow \\  & & \downarrow & \downarrow & \downarrow \\ $	$ST_{PO}$	$ \begin{array}{c c}  & \downarrow & \downarrow & \downarrow \\  & \uparrow & \downarrow & \downarrow \\  & \downarrow & \downarrow & \downarrow \\  & \uparrow & \downarrow & \downarrow \\  & \downarrow & \downarrow & \downarrow $
BODE PLOT: LET s = jω MAGNITUDE	$\begin{vmatrix} \frac{1}{1+j\omega\tau_{PL}} \end{vmatrix} = \frac{1}{\sqrt{1^2 + (\omega\tau_{PL})^2}}$ $ H  \land \qquad $	$\left  \frac{1}{0 + j\omega \tau_{PO}} \right  = \frac{1}{\omega \tau_{PO}}$ $[dB] \qquad -20dB/dec \qquad \omega$	$\begin{vmatrix} \frac{1}{1 - j\omega\tau_{PR}} \end{vmatrix} = \frac{1}{\sqrt{1^2 + (\omega\tau_{PR})^2}}$ [dB] $-20\text{dB/dec}$
PHASE	$ \frac{\sqrt{H}}{[\text{deg}]} $ $ -45^{\circ} $ $ -90^{\circ} $ $ \frac{1/(1+j\omega\tau_{PL})}{(-90)^{\circ}} = -\tan^{-1}(\omega\tau_{PL}) $	$ \frac{\sqrt{H}}{[\text{deg}]} \qquad \omega $ $ -90^{\circ} \qquad \omega $ $ \frac{1/(0+j\omega\tau_{PO}) = -\tan^{-1}(\omega\tau_{PO}/0) = -90^{\circ}}{(\omega\tau_{PO}/0)} = -90^{\circ} $	$ \frac{\frac{\frac{H}{[\text{deg}]}}{1}}{1/(1-j\omega\tau_{PR})} = \tan^{-1}(\omega\tau_{PR}) $

## **GENERAL TRANSFER FUNCTION**