

Transfer Function

A transfer function is written as

$$G(s) = Y(s) / X(s)$$

where $Y(s)$ is the output function, $X(s)$ is the input function and $s = i \omega$.

$G(s)$ is transformed with angular frequency ω , amplitude $A(\omega) = |G|$ and phase $P(\omega) = \arg(G)$. Note that $G(s) = G(i \omega) = |G| \exp(i \arg(G)) = A(\omega) \exp(i P(\omega))$

Bode Diagram

This is an example using $G(s) = 1/(1+s)$.

To draw the Bode diagram, we need to find the amplitude $A(\omega)$ and phase $P(\omega)$.

Bode Diagram

This is an example using the transfer function

$$G(s) = \frac{1}{1+s}$$

Define $G(s) = \frac{1}{1+s}$

done

cExpand(G(i\omega))

$$\frac{1}{1+\omega^2} - \frac{1 \cdot i}{1+\omega^2} \cdot \omega$$

The amplitude is:

$$A = \sqrt{\text{combine}\left(\left(\frac{1}{1+\omega^2}\right)^2 + \left(-\frac{1}{1+\omega^2} \cdot \omega\right)^2\right)}$$

$$A = \sqrt{\frac{1}{\omega^2+1}}$$

Change to deciBel representation:

20*log(ans) | \omega=x

$$20 \cdot \log(A) = 10 \cdot \log\left(\frac{1}{x^2+1}\right)$$

A(\omega)

The phase is:

$$P = \tan^{-1}\left(\frac{-\frac{1}{1+\omega^2} \cdot \omega}{\frac{1}{1+\omega^2}}\right)$$

ans | \omega=x

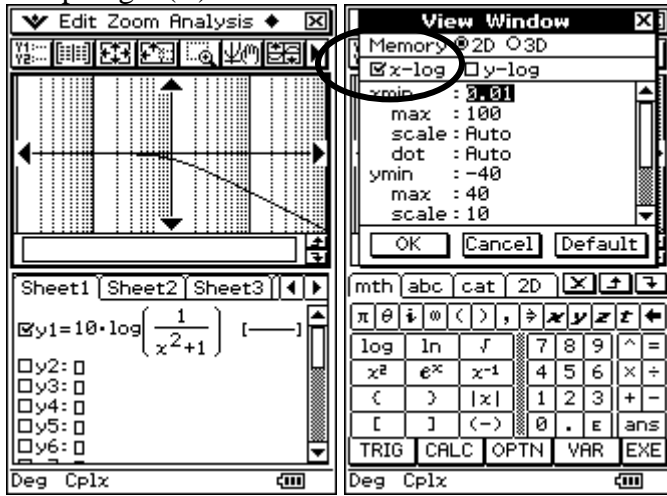
$$P = -\tan^{-1}(\omega)$$

$$P = -\tan^{-1}(x)$$

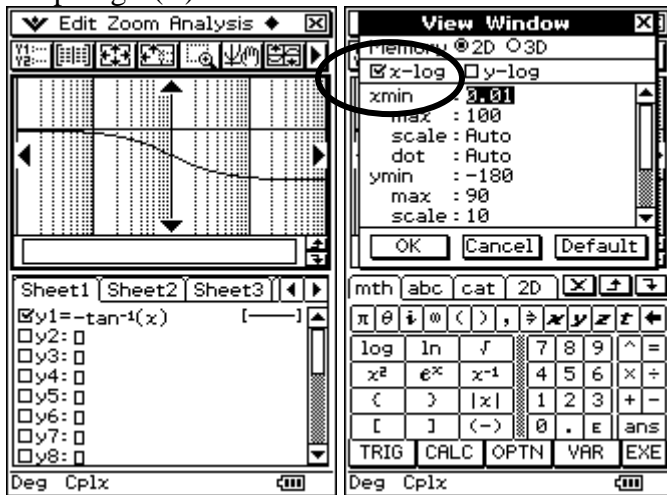
P(\omega)

To draw the graph with ClassPad Graph application, we must first change ω to x and change the View Window settings. When drawing $A(\omega)$ and $P(\omega)$, it is a good idea to set the x -axis to the log scale setting found in the View Window dialog.

Graphing $A(\omega)$:



Graphing $P(\omega)$:



Nyquist Path

These are eActivity screen shots showing the calculations and setting needed to draw the Nyquist path for $G(s)=1/(1+s)$.

We will use parametric equations to draw the path.

File Edit Insert Action

Nyquist Path

Define $G(s)=\frac{1}{1+s}$ done

Letting $s=it$, we have:
 $\text{cExpand}(G(it))\Rightarrow\text{Nyquist}$

$$\frac{1}{1+t^2} - \frac{1 \cdot i}{1+t^2} \cdot t$$

Nyquist Path

Alg Standard Cplx Deg

File Type GMem

Sheet1 Sheet2 Sheet3

$xt1=\text{re}(\text{Nyquist})$
 $yt1=\text{im}(\text{Nyquist})$

$xt2: \square$
 $yt2: \square$
 $xt3: \square$
 $yt3: \square$
 $xt4: \square$

Deg Cplx

View Window

Memory @2D O3D

x-log y-log

xmin : 1.5
 max : 1.5
 scale : 0.5
 dot : 0.01948051948

ymin : -1
 max : 1
 scale : 0.5

OK Cancel Default

mth abc cat 2D

π	θ	i	ω	()	,	\div	\times	$\sqrt{}$	\leftarrow
log	ln	$\sqrt{}$	7	8	9	\wedge	=		
x^2	e^x	x^{-1}	4	5	6	\times	\div		
())	x	1	2	3	+	-		
[]	(-)	θ	.	E	ans				
TRIG	CALC	OPTN	VAR	EXE					

Deg Cplx

View Window

Memory @2D O3D

x-log y-log

ymin : -1
 max : 1
 scale : 0.5
 dot : 0.02631578947

t0min : -6.2831853071
 max : 6.28318530718
 step : 0.05235987755

OK Cancel Default

mth abc cat 2D

π	θ	i	ω	()	,	\div	\times	$\sqrt{}$	\leftarrow
log	ln	$\sqrt{}$	7	8	9	\wedge	=		
x^2	e^x	x^{-1}	4	5	6	\times	\div		
())	x	1	2	3	+	-		
[]	(-)	θ	.	E	ans				
TRIG	CALC	OPTN	VAR	EXE					

Deg Cplx