EE 303 MP class
09/08/09

pole $=$ zero of $\frac{1}{f(s)}$
of $f(s)$

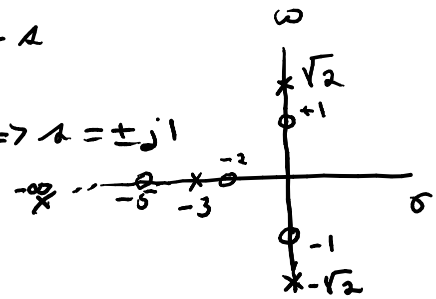
a zero of $f(s)$ is where $f(s)$ is analytic and $=0$

for rational functions $f(s) = \frac{n(s)}{d(s)}$, n & $d =$ polynomial
$s = \sigma + j\omega$

Ex: $f(s) = \frac{(s^2+1)(s+2)(s+5)}{(s+3)(s^2+2)} \underset{s\to\infty}{\approx} \frac{s^4}{s^3} \sim s$

zeros at: $s=-5$, $s=-2$, $s^2=-1 \Rightarrow s = \pm j1$

poles at: $s=-3$, $s^2=-2 \Rightarrow s = \pm j\sqrt{2}$
$s=\infty$



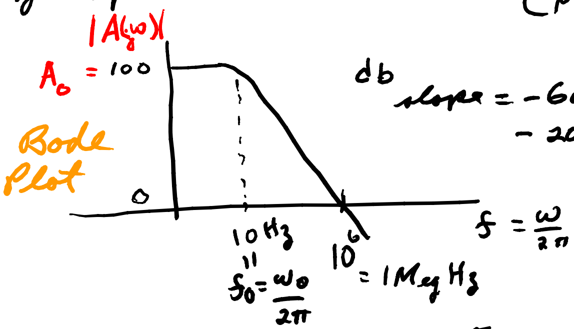
other kinds of poles are in $\tanh(s)$

things of other types are $\sqrt{s}$ (branch point @ $s=0$)

$e^{-\frac{1}{s}}$ (at $s=0$, has an essential singularity)

limits of poles are essential singularities

for op amps: p. 90 & 121 (μA741)



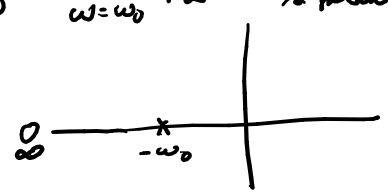
op-amps gain $A(s) = \frac{V_{out}(s)}{V_{in}}$ eq. (2.24)

$= \frac{A_0}{1 + s/\omega_0}$; $A_0 > 0$, $A_0 =$ constant $=$ DC gain

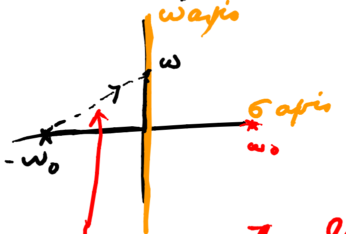
$$|A(j\omega)| = \frac{|A_0|}{|1 + j\omega/\omega_0|} = \frac{A_0}{\sqrt{1 + (\omega/\omega_0)^2}} = \Big|_{\omega=\omega_0} \frac{A_0}{\sqrt{2}}$$

s plane

here $A(s)$ has a zero @ $s=\infty$
a pole @ $s=-\omega_0$



when $\sigma = 0$, $s = j\omega$, ω = real frequency

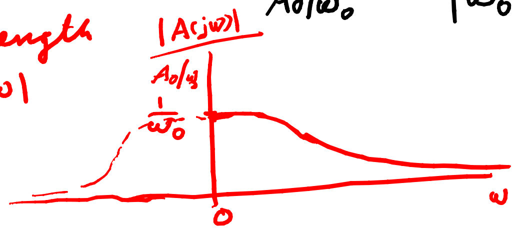


this vector's length gives $|\omega_0 + j\omega|$

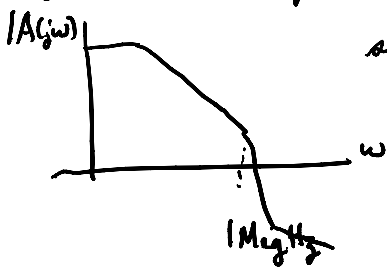
are looking at $|A(j\omega)| = \dfrac{A_0}{|1 + j\,\omega/\omega_0|}$

if normalize by

$$\frac{|A(j\omega)|}{A_0/\omega_0} = \frac{1}{|\omega_0 + j\omega|}$$



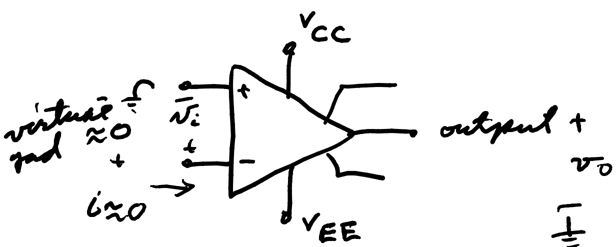
Measured curve for μA741



so here $A(s) = \dfrac{A_0}{(1 + s/\omega_0)(1 + s/\omega_1)}$

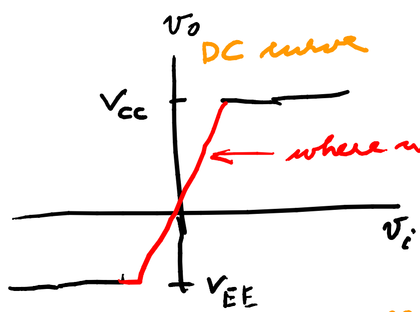
gives 2nd order approximation

p. 878



PSpice symbol for the μA741

see p. 894 for transistor version.



|↔| very small ≈ 10^{-9} v

idealized to