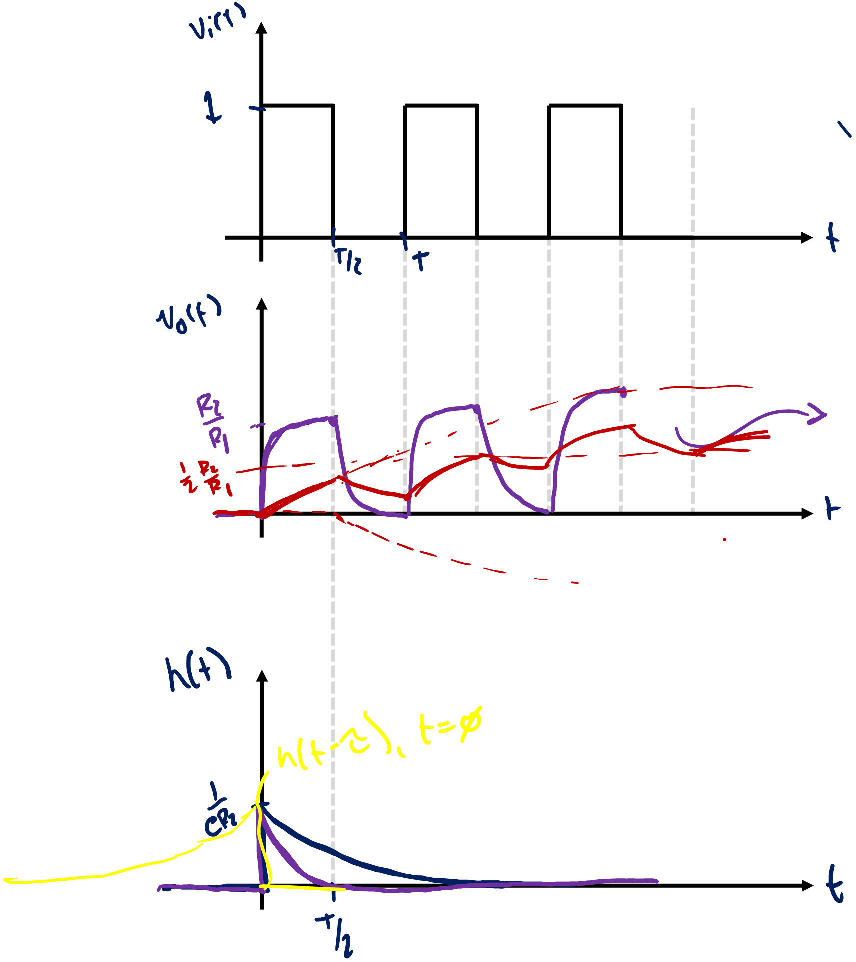
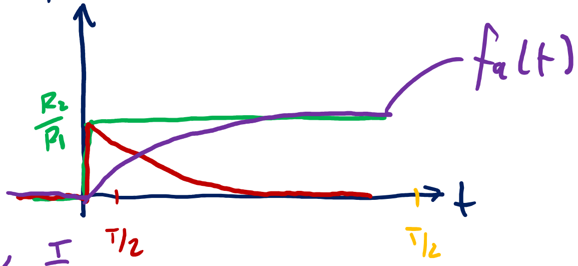


$\tau = R_2 C \ll \frac{T}{2}$

$\tau = R_2 C \gg \frac{T}{2}$

$$f_a(t) = \frac{R_2}{R_1}\left[1 - e^{-\frac{1}{R_2 C}t}\right]u(t)$$



$$H(s) = \frac{R_2}{R_1}\,\frac{\frac{1}{CR_2}}{s + \frac{1}{CR_2}}$$

$$h(t) = \frac{1}{CR_1}\,e^{-\frac{1}{CR_2}t}\,u(t)$$

$$v_o(t) = \int_0^{\infty} h(t-\tau)\,v_i(\tau)\,d\tau$$

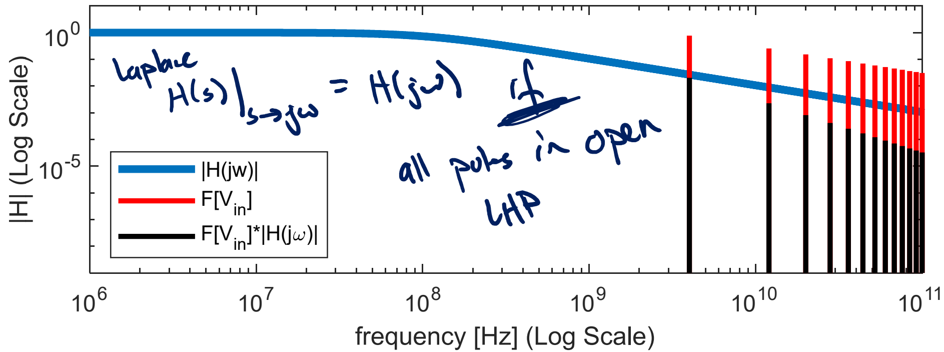
End of Material for Midterm 2

- Midterm Exam #2 Friday Apr 26th
  - Lectures 20 - 33
  - Homeworks 6 - 9
  - Quiz 3 - 4
  - Chapter 17 (17.1 -17.5) and Chapter 14 (all)
  - Experiment 3

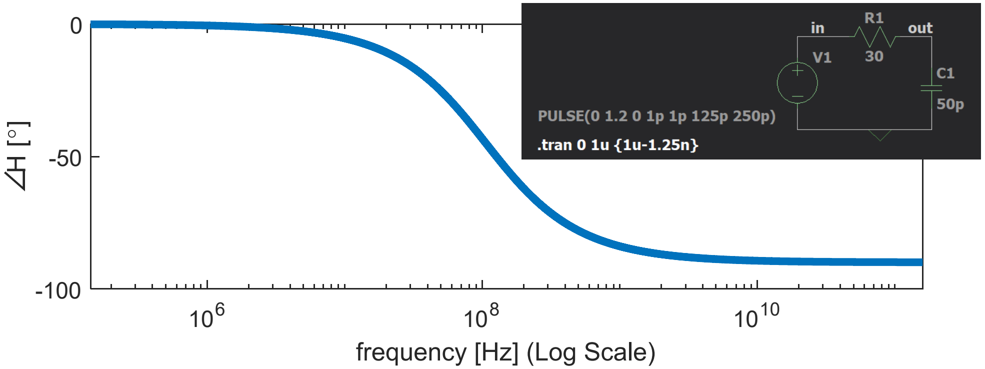
Chapter 15

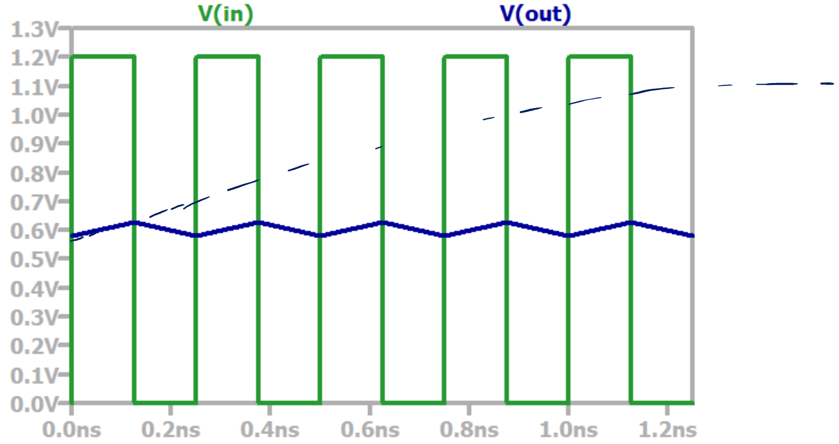
FREQUENCY RESPONSE

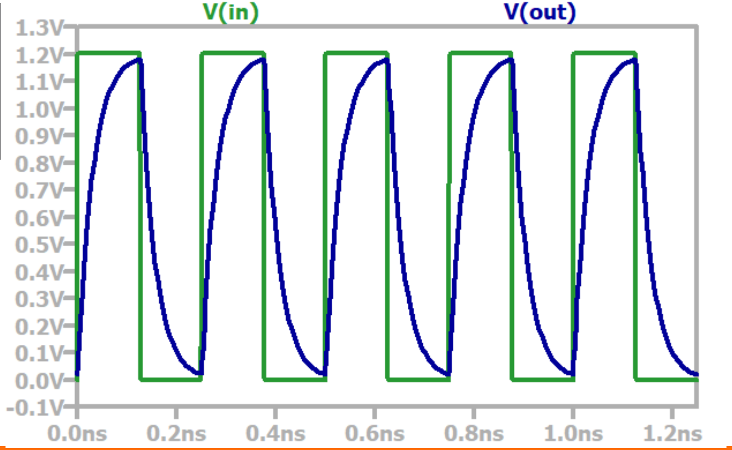
L22 - Frequency Response Interpretation



Laplace $H(s)\big|_{s \to j\omega} = H(j\omega)$ if all poles in open LHP





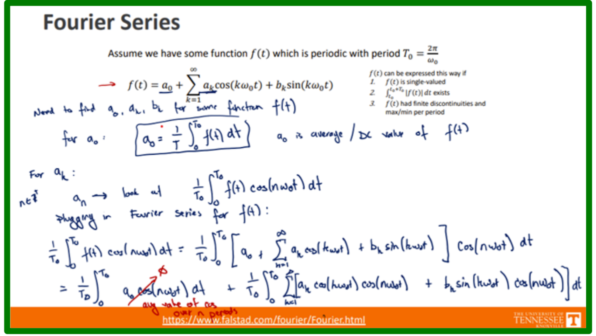


Laplace Explanation

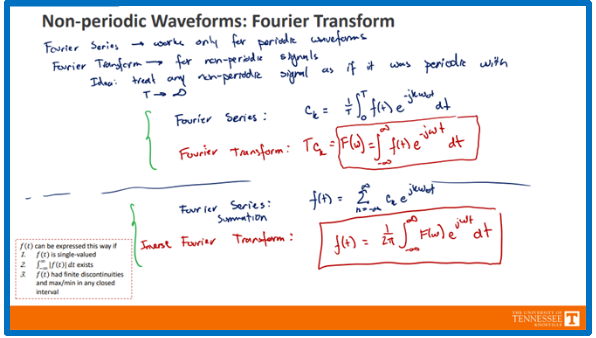
$$F(s) = \int_{0^-}^{+\infty} e^{-st} f(t)\,dt = \int_{0^-}^{+\infty} \overbrace{e^{-\sigma t} e^{-j\omega t}}^{e^{-st}} f(t)\,dt$$

$$f(t) = \frac{1}{2\pi j}\int_{\sigma_0 - j\infty}^{\sigma_0 + j\infty} e^{\sigma t} e^{j\omega t} F(s)\,ds$$

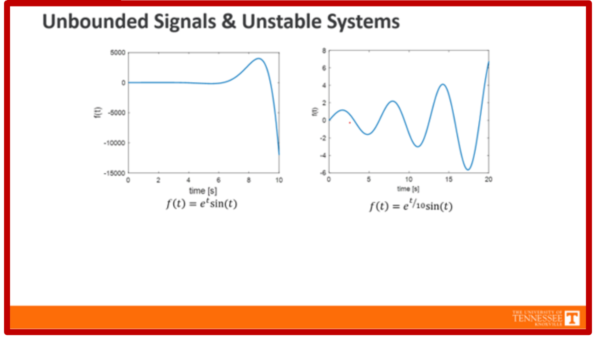
L21



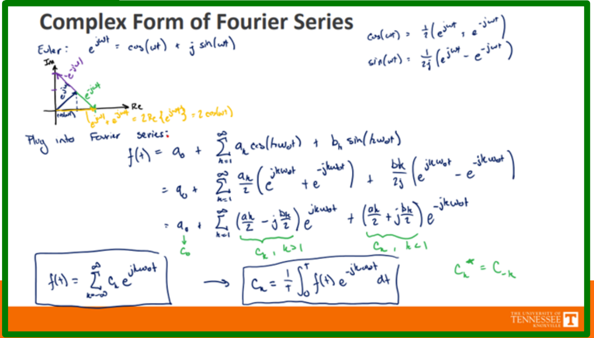
L24



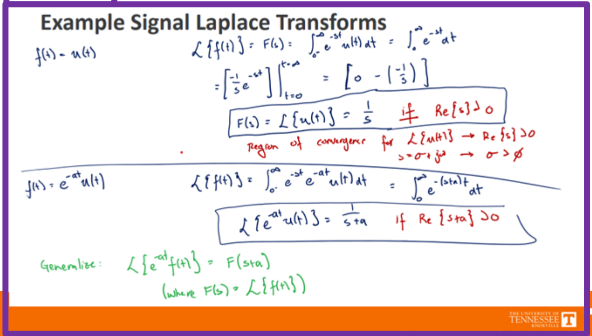
L30



L23



L25

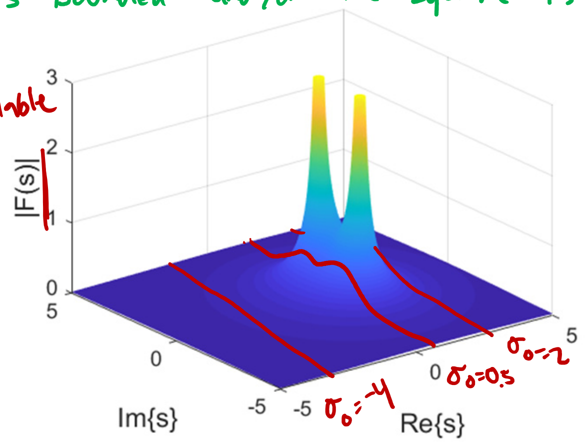


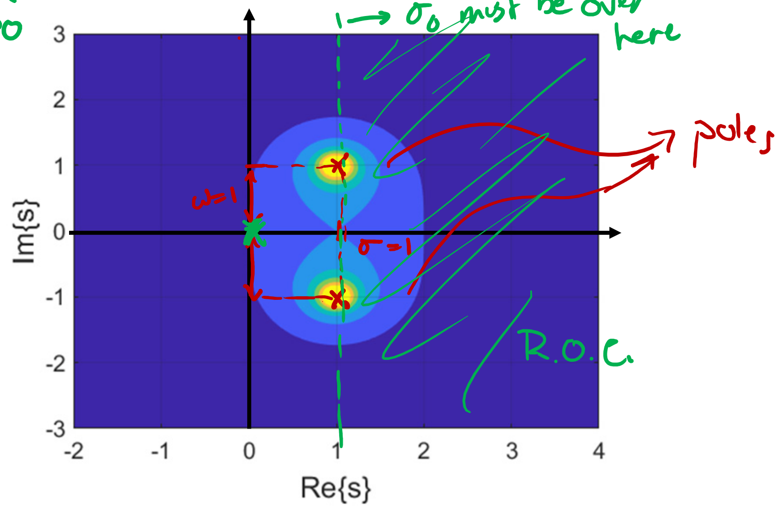
The s-plane

The Region of convergence of a Laplace transform is the complex plane to the right of all poles

If all poles are in the open left half-plane, (LHP) the signal is bounded and/or the system is BIBO stable

RHP poles ⟺ unstable





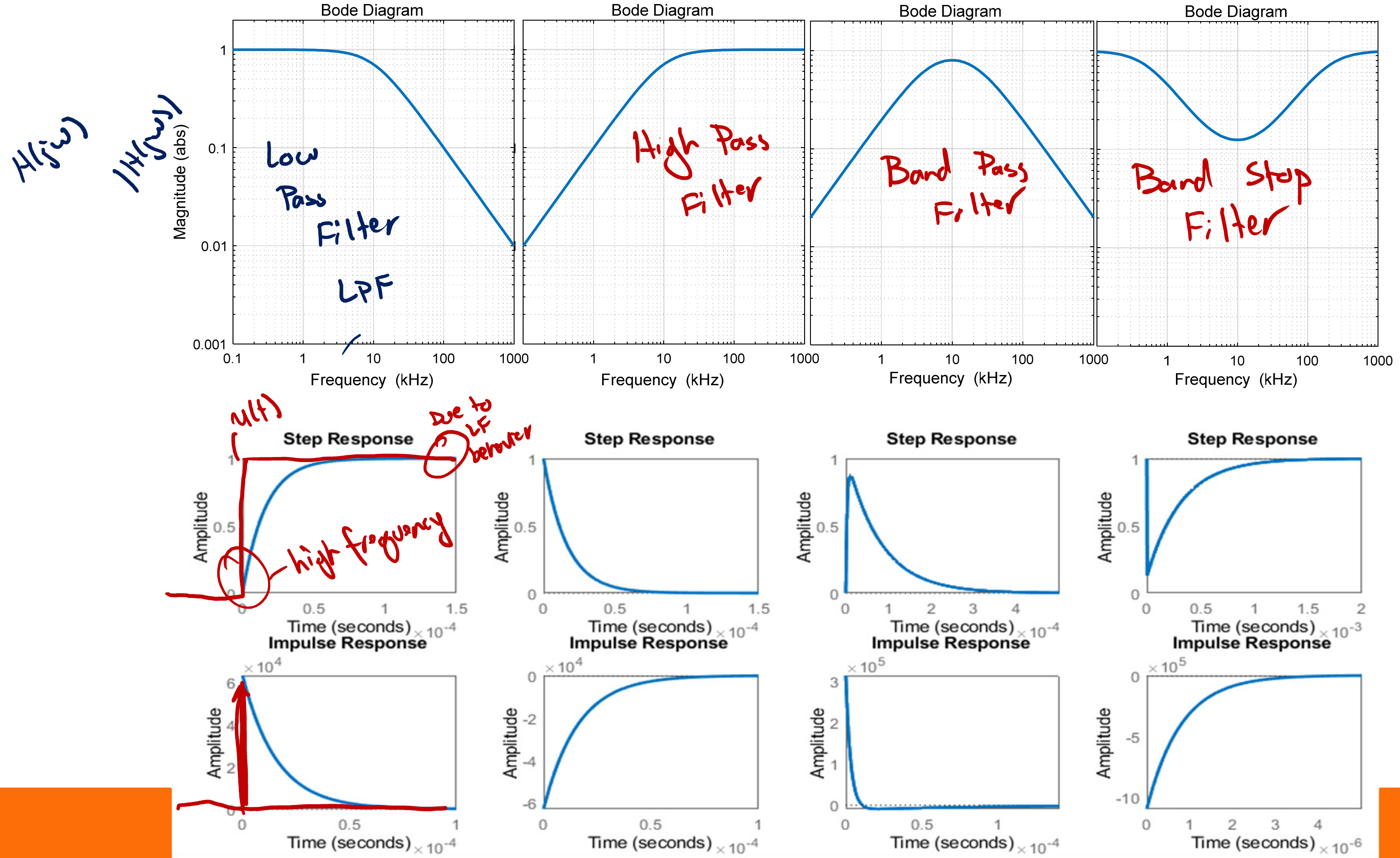
$$F(s) = \frac{1}{s^2 - 2s + 2} = \frac{1}{(s - (1 + j))(s - (1 - j))}$$

ROC is $Re\{s\} > 1$

$f(t) = e^t \sin(t)$

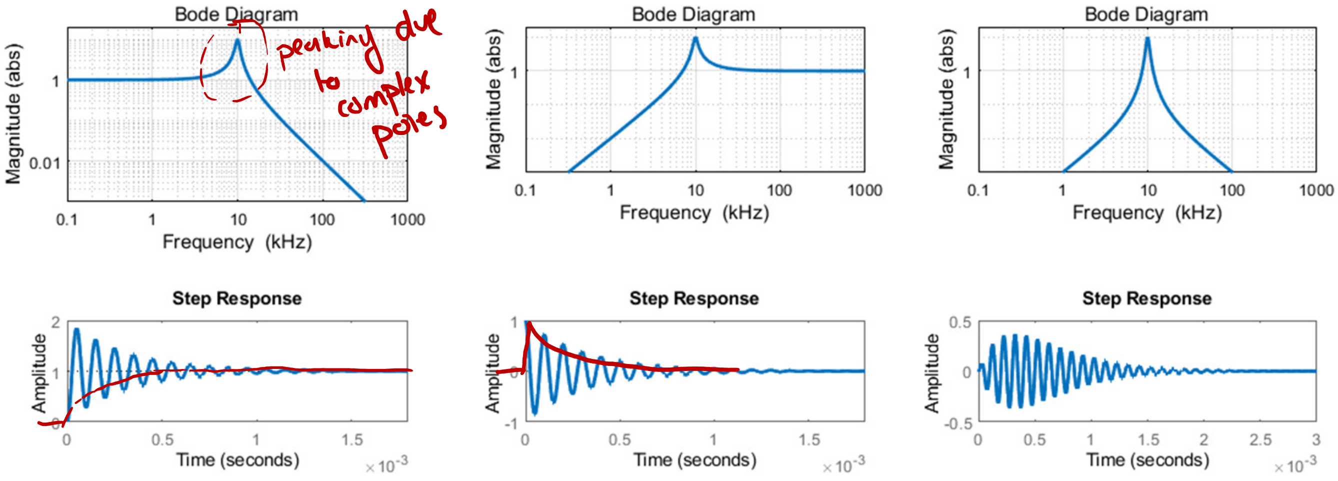
$F(s) = \int_{0^-}^{\infty} \underbrace{e^{-st} e^t}\sin(t)\,dt$ → Need $Re\{s\} > 1$ for convergence

Frequency Response and Circuit Behavior

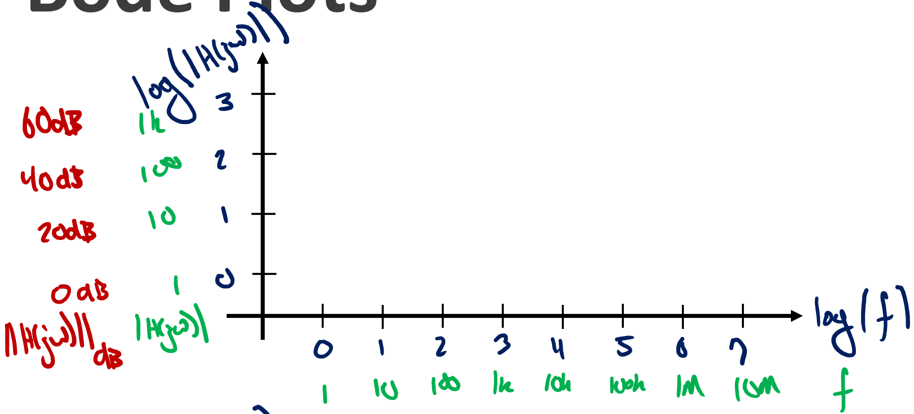


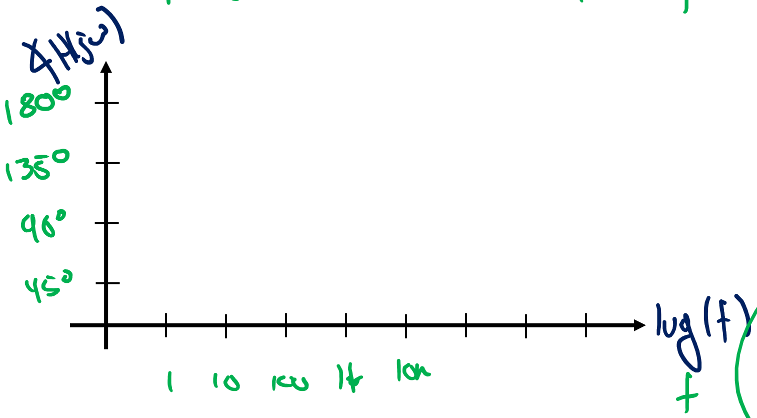
Complex Poles

low Pass　　　high pass　　　Band pass



Bode Plots





$\|H(j\omega)\|_{dB} = 20\log(|H(j\omega)|)$

Frequency response:

@ ω_x

fourier component of $v_i(t)$ at ω_x is $Ae^{j\varphi}$

output component at ω_x is $A|H(j\omega_x)|e^{j(\varphi + \angle H(j\omega))}$

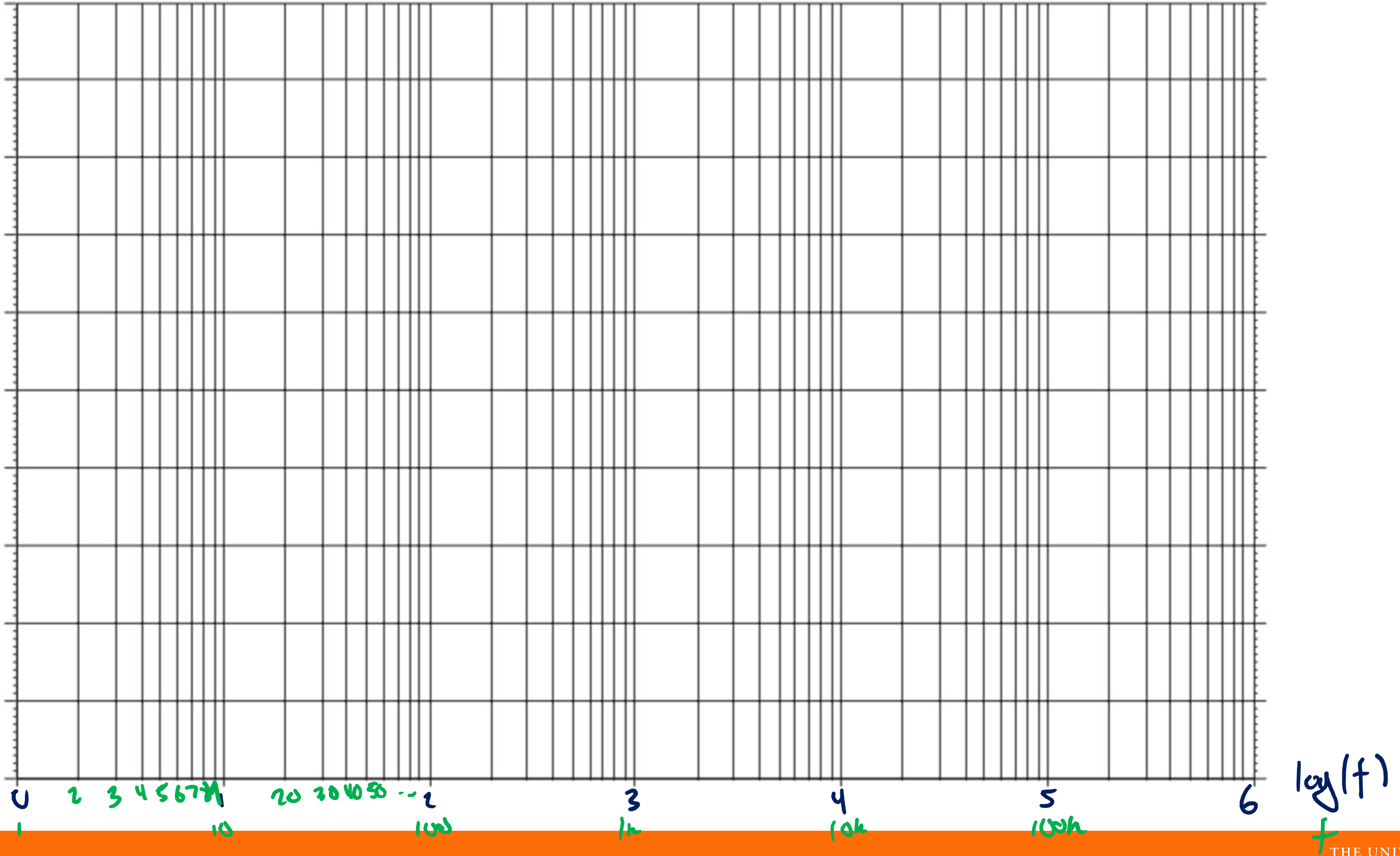
- Magnitudes multiply
- Phases Add

$\log(A|H(j\omega)|) = \log(|V_o @ \omega_x|)$

$= \log(A) + \log(|H(j\omega)|)$

- log of Magnitudes add

Semilog Paper



dB Scale

Decibels

$$\| G \|_{\mathrm{dB}} = 20 \log_{10}\left(\| G \| \right)$$

Decibels of quantities having units (impedance example): normalize before taking log

$$\| Z \|_{\mathrm{dB}} = 20 \log_{10}\left(\frac{\| Z \|}{R_{base}} \right)$$

Table 8.1. Expressing magnitudes in decibels

Actual magnitude	*Magnitude in dB*
1/2	– 6dB
1	0 dB
2	6 dB
5 = 10/2	20 dB – 6 dB = 14 dB
10	20dB
$1000 = 10^3$	$3 \cdot 20\text{dB} = 60$ dB

5Ω is equivalent to 14dB with respect to a base impedance of R_{base} = 1Ω, also known as 14dBΩ.

60dBμA is a current 60dB greater than a base current of 1μA, or 1mA.