For all time:

\[ e^{j\omega t} \}

Phase \[ \rightarrow \]
Magnitude

\[ e^{j\omega t} \}

\[ = \]

\[ |H(e^{j\omega})| \]

\[ = |H(s)| \]

\[ e^{j\phi(s)} \]

\[ \Phi(s) \]

\[ = \]

\[ H(s) \]

Evaluates at \[ s=j\omega \]

Transfer Function

\[ \rightarrow \]

System Response of \( LTI \) Systems
\[ m = m_0 \]
\[ \omega = \omega_0 \]
\[ \phi = \phi_0 \]

\[ \text{Real LTI systems} \]

Phase is odd

Mac. is even

If system is Real: Has Real Coefficients

\[ \text{IFF, even. Has Real Coefficients} \]

\[ \text{He}(s) \text{ is Real (Not Imaginary)} \]

\[ \text{Real LTI systems} \]
\[
\frac{2}{\pi} = \frac{10}{\pi s} = \frac{10}{\sin(s)} \quad (s > 0) \quad \text{H}^7
\]

Why or why not?

Could the system have the frequency response given below?

\[
\left( \frac{2}{\mu} - \gamma \right) \cos 2\gamma + (\gamma \cos \gamma) = 30 \cos \gamma = (x)H
\]

\[
(\gamma \cos \gamma) + \left( \frac{2}{\mu} + \gamma \right) \cos 2\gamma = (x)\]

Suppose that the input to an LTI system is \(x(t)\) given below. The corresponding output is \(y(t)\), also given below.
Also use log scale for u

- log scale useful in analyzing
- log scale useful in analyzing

 Analogy: Heavenly, ...

 Easy to show large dynamic range.

 Why use log magnitude?

 For real systems.

 \[ 20 \log_{10} |H(\omega)| = \Re \{ H(\omega) \} \]

 Easy method for sketching

 Base plots
\[
\left(1 + \frac{e^2}{\mu^2} \right) A \left(1 + \frac{D}{\mu R} \right) A - \left(1 + \frac{D}{\mu R} \right) A
\]

\[
2 \log_{10} |H_{(m)}| = \phi K + \phi (\mu^2) + \left(1 + \frac{13}{3} \right) \phi (\mu^2)
\]

Boole Phase

\[
\left| \begin{array}{c}
\frac{e^2}{\mu^2} + 1 \\
\frac{1}{\mu^2} + 1 \\
\frac{1}{\mu^2} + 1 \\
\frac{1}{\mu^2} + 1 \\
\end{array} \right| = \left| \begin{array}{c}
2 \log_{10} |K| + 2 \log_{10} |K| \\
2 \log_{10} |K| + 2 \log_{10} |K| \\
2 \log_{10} |K| + 2 \log_{10} |K| \\
2 \log_{10} |K| + 2 \log_{10} |K| \\
\end{array} \right|
\]

Boole Magnitude:
\[
H(s) = \frac{(s+p_1)(s+p_2)}{s(s+1)}
\]

Notes:
- Start with \( H(s) \) and factor into poles + zeros.
- Assume real poles + zeros.
- Poles + zeros:
  \( p_1 \) and \( p_2 \).
- \( s \) zeros.

Remark:
- Integral steps to get to base poles.
\[
\sqrt{\epsilon_0} = \frac{z^2 \left(1 + \frac{\partial^0}{m^2} \right) \left(1 + \frac{\partial^0}{m^2} \right)}{\left(1 + \frac{\partial^0}{m^2} \right) m^2} = \frac{2^{001} \left(1 + \frac{\partial^0}{m^2} \right) \left(1 + \frac{\partial^0}{m^2} \right) \left(1 + m^2 \right)}{01 \cdot \left(1 + \frac{\partial^0}{m^2} \right) m^2} = \frac{(001 + m^2) (001 + m^2) \left(1 + m^2 \right)}{(01 + m^2) m^2} = (m^2 H)^H \]

\[
(001 + s) (001 + s) \left(1 + s \right) \frac{(01 + s) s}{(01 + s) s} = (s^2 H) \sqrt{\text{EX}}
\]
Linear Term
20dB/decade Slope

\[
\frac{10^r}{3^{1/3}} \cdot 10^{20\log_{10}10} = 20\log_{10}10 \cdot |m| - 20\log_{10}10
\]

\[
\frac{3^{1/3}}{3^{1/3}} \cdot 10^{20\log_{10}10} = 20\log_{10}10 \cdot |m| + 1
\]

If \( m > 20 \)

\[
\frac{3^{1/3}}{3^{1/3}} \cdot 10^{20\log_{10}10} \geq 20\log_{10}10 \cdot |m| + 1
\]

If \( m \leq 0 \)

\[
\frac{3^{1/3}}{3^{1/3}} \cdot 10^{20\log_{10}10} \leq 20\log_{10}10 \cdot |m| + 1
\]

\[
\text{If } a \text{ is real, } |a| = \frac{3^{1/3}}{3^{1/3}} \cdot 10^{20\log_{10}10}
\]

Magnitude
\[ \log_{10} (\text{on/off}) \]

\[ \text{slope} \ 20 \text{ dB/dec} \]

\[ \text{m > 20} \]

\[ \text{of 5 by 3 dB} \]

\[ \text{off w = 0} \]

\[ 1 + \frac{36}{10} \]

\[ 20 \log_{10} \]
\[
\begin{align*}
\sinh x &= (1)_{\,1-\cosh} : a = 3 \Rightarrow 1 \\
\frac{\theta_0}{90^\circ} &\approx (\text{deg})_{\,1-\text{max}} : a > 3 \Rightarrow 1 \\
0 &\approx (0)_{\,1-\text{max}} : a \gg 3 \Rightarrow 1 \\
\left(\frac{16}{316}\right)_{\,1-\text{max}} &= \left(\frac{\text{re}(\text{real})}{\text{imag}}\right)_{\,1-\text{max}} = H(c, w) = (c, w) \\
1 + \frac{316}{3} &= \frac{H(c, w)}{\text{plot}}
\end{align*}
\]
PROBLEM 1 (25%) 

To compensate for the "tinny" character of his small speakers and the high-frequency noise of a typical AM rock station, the manufacturer of a proposed miniature radio receiver has hired you to design a "bass boost and treble cut" fixed tone control interstage network.

(a) The approximate frequency response the manufacturer hopes to achieve is shown by the solid straight lines on the graph below. Note that no scale is given on the ordinate. Only relative values of the gains at various frequencies are important, since extra wide-band gain is easy to provide (and the radio user will in any event have a volume control to adjust the overall gain to his/her desires). Find a formula for a rational function $H_1(s)$ corresponding to a stable causal system whose magnitude for imaginary $s$ has approximately the same shape as these asymptotes, up to an arbitrary constant gain factor.

$$H(s) = \frac{K (s+500)}{(s+100) (s+2500)}$$