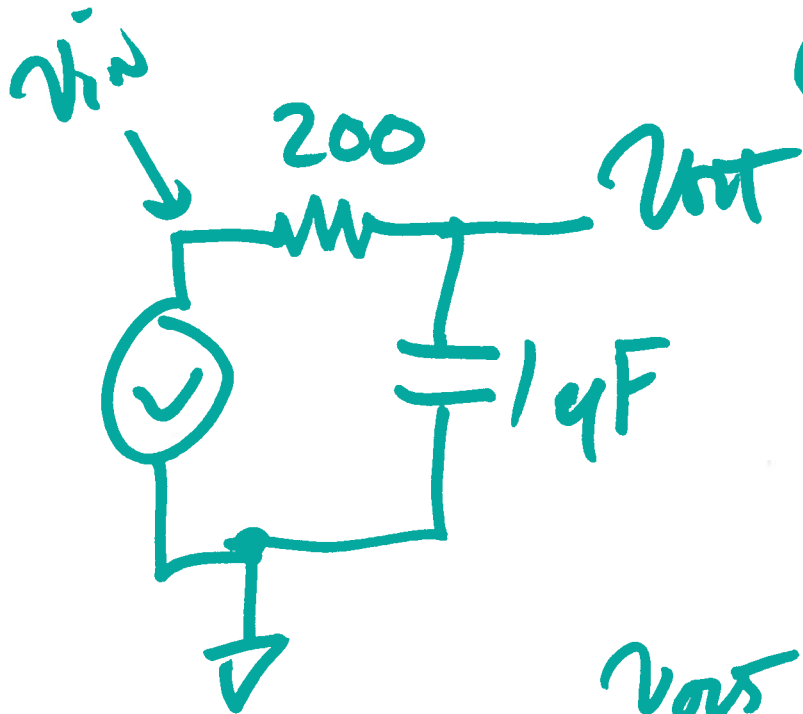


# EE 220

## Lecture 25

### Circuits I



$$v_{out} = v_{in} \cdot \frac{\frac{1}{j\omega 1\mu F}}{\frac{1}{j\omega 1\mu F} + 200}$$

$$\frac{v_{out}}{v_{in}} = \frac{1}{1 + j\omega \cdot 200 \cdot 10^{-6}}$$

$$\frac{v_{out}}{v_{in}} \approx \frac{1 + j\omega}{1 + j\omega 200 \cdot 10^{-6}} \quad f_p = f_{3dB} = \frac{1}{2\pi \cdot 200 \cdot 10^{-6}}$$

$$\left| \frac{v_{out}}{v_{in}} \right| = \frac{1}{\sqrt{1^2 + (2\pi f \cdot 200 \cdot 10^{-6})^2}} = \frac{1}{\sqrt{1 + \left(\frac{f}{f_{3dB}}\right)^2}}$$

$$\angle \frac{v_{out}}{v_{in}} = -\tan^{-1} \frac{2\pi f \cdot 200 \cdot 10^{-6}}{1} = -\tan^{-1} \frac{f}{f_{3dB}}$$

$$20 \log \frac{1}{\sqrt{2}} = -3 \text{ dB}$$

$$f \ll \frac{1}{2\pi \cdot 200 \cdot 10^{-6}} \rightarrow \left| \frac{v_{out}}{v_{in}} \right| = 0 \text{ dB}$$

$$f \gg \frac{1}{2\pi \cdot 200 \cdot 10^{-6}} \quad \left| \frac{v_{out}}{v_{in}} \right| \approx \frac{1}{\frac{f}{f_{3dB}}}$$

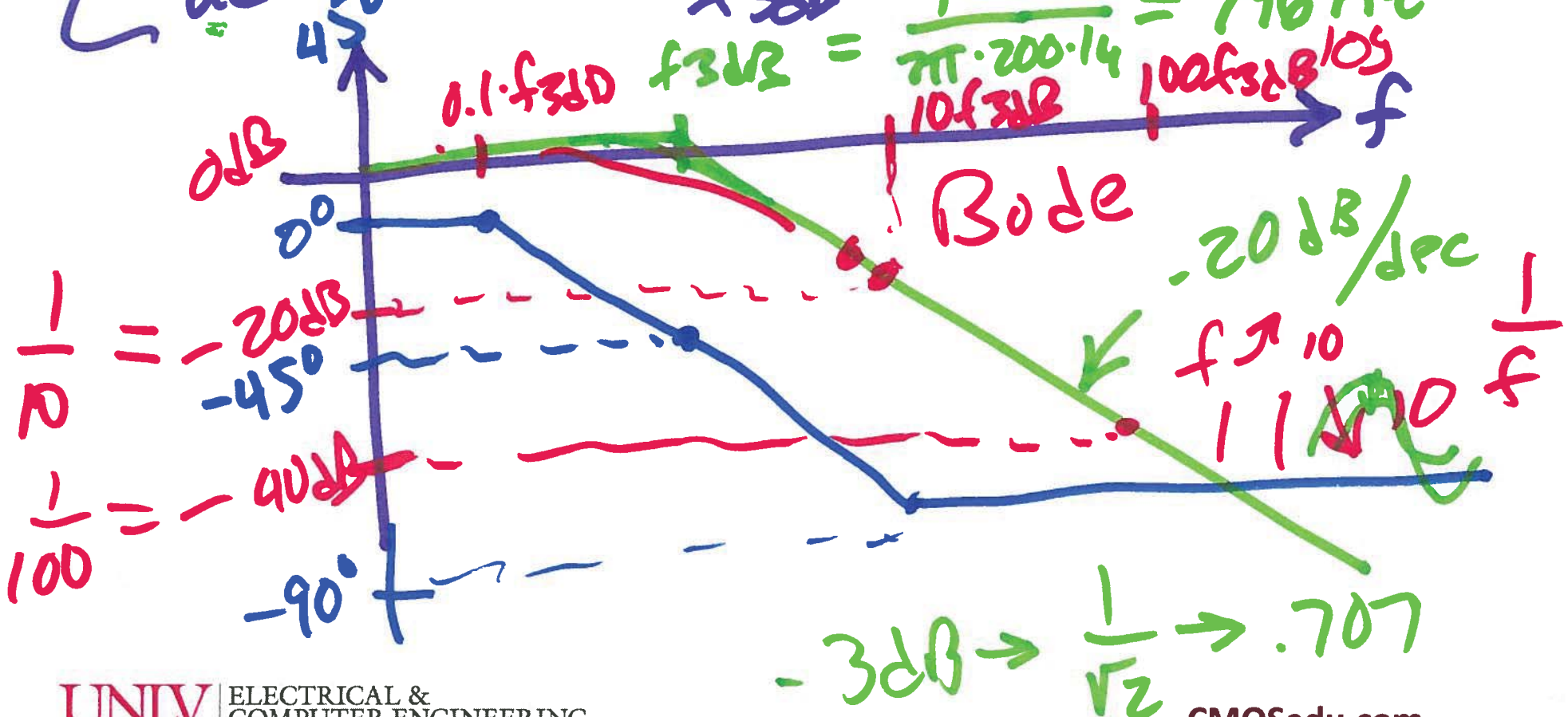
2)

$$\left| \frac{v_{out}}{v_{in}} \right| = \frac{1}{\sqrt{1 + \left(\frac{f}{f_{3dB}}\right)^2}} \Rightarrow 20 \log \frac{1}{\sqrt{1 + \left(\frac{f}{f_{3dB}}\right)^2}}$$

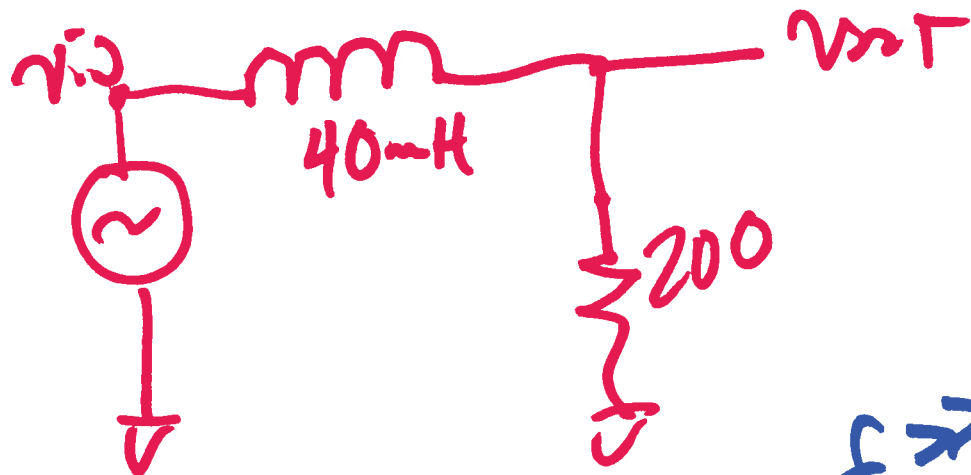
$$\angle \frac{v_{out}}{v_{in}} = -\tan^{-1} \frac{f}{f_{3dB}}$$

$$\frac{1}{j \cdot 2\pi f \cdot C} \quad f=0 \text{ (DC)}$$

$$f_{3dB} = \frac{1}{\pi \cdot 200 \cdot 14} = 796 \text{ Hz}$$



3)

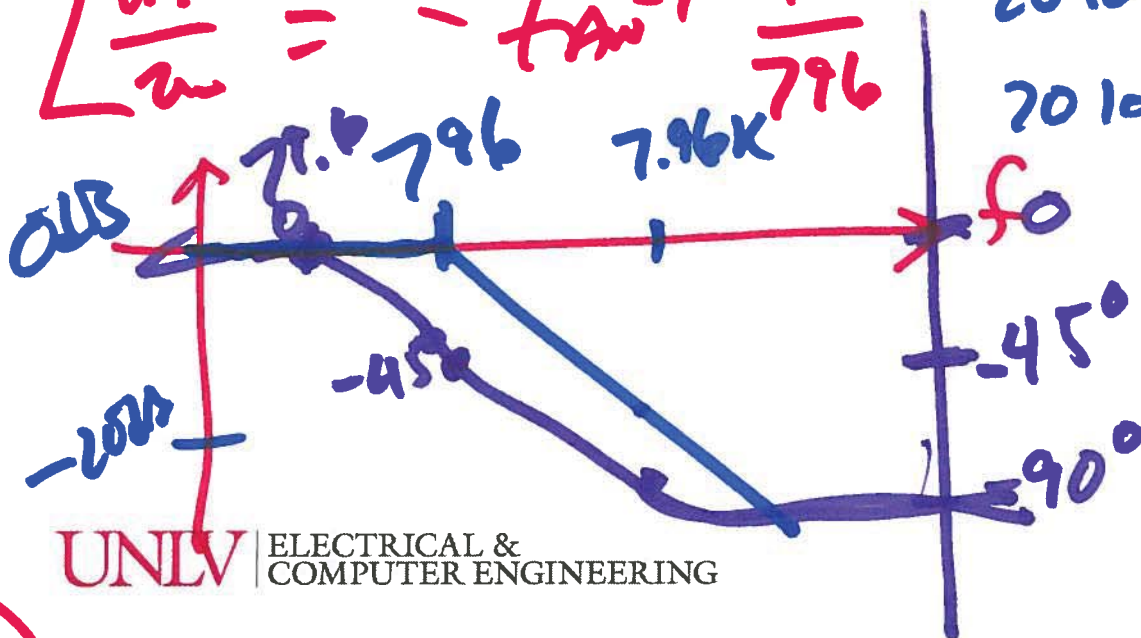


$$\frac{v_o(t)}{v_i(t)} = \frac{200}{200 + j \cdot 2\pi \cdot f \cdot 40\text{mH}}$$

$$\left| \frac{v_o(t)}{v_i(t)} \right| = \frac{1}{\sqrt{1 + \left(\frac{f}{796}\right)^2}}$$

$$\approx \frac{796}{f} = \frac{1}{1 + j \frac{f}{796}}$$

$$\angle \frac{v_o(t)}{v_i(t)} = -\tan^{-1} \frac{f}{796}$$



$$20 \log \frac{796}{f}$$

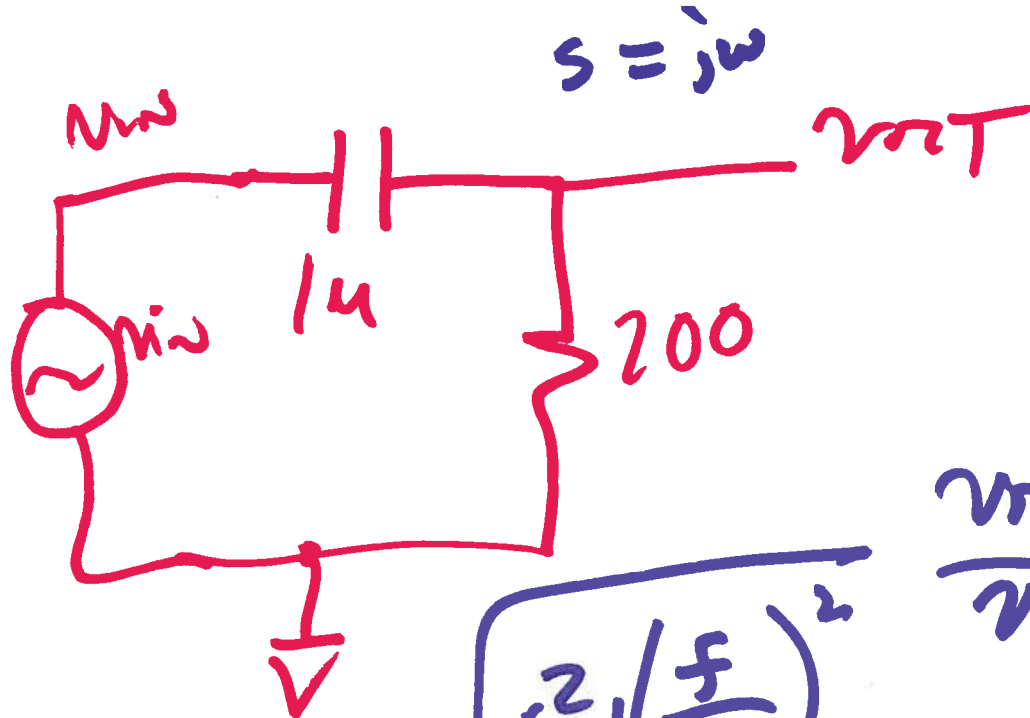
$$20 \log 796 - 20 \log f$$

$$f_{3dB} = \frac{1}{2\pi \cdot \frac{40\text{mH}}{200}}$$

$$= \frac{1}{2\pi \cdot 200\mu}$$

$$= 796\text{Hz}$$

4)



$$\frac{v_{out}}{v_{in}} = \frac{200}{200 + \frac{1}{j \cdot 2\pi f \cdot 10^{-6}}}$$

$$\frac{v_{out}}{v_{in}} = \frac{0 + j \cdot 2\pi f \cdot 200 \cdot 10^{-6}}{1 + j \cdot 2\pi f \cdot 200 \cdot 10^{-6}}$$

$$\left| \frac{v_{out}}{v_{in}} \right| = \frac{\sqrt{0^2 + \left(\frac{f}{796}\right)^2}}{\sqrt{1 + \left(\frac{f}{796}\right)^2}}$$

$$= \frac{0 + j \frac{f}{796}}{1 + j \frac{f}{796}}$$

$$\angle \frac{v_{out}}{v_{in}} = \frac{f}{796} \cdot \frac{90}{\sqrt{1 + \left(\frac{f}{796}\right)^2}}$$

$$\angle \frac{v_{out}}{v_{in}} = \tan^{-1} \frac{f}{796}$$

5)

$$\frac{V_{out}}{V_{in}} =$$

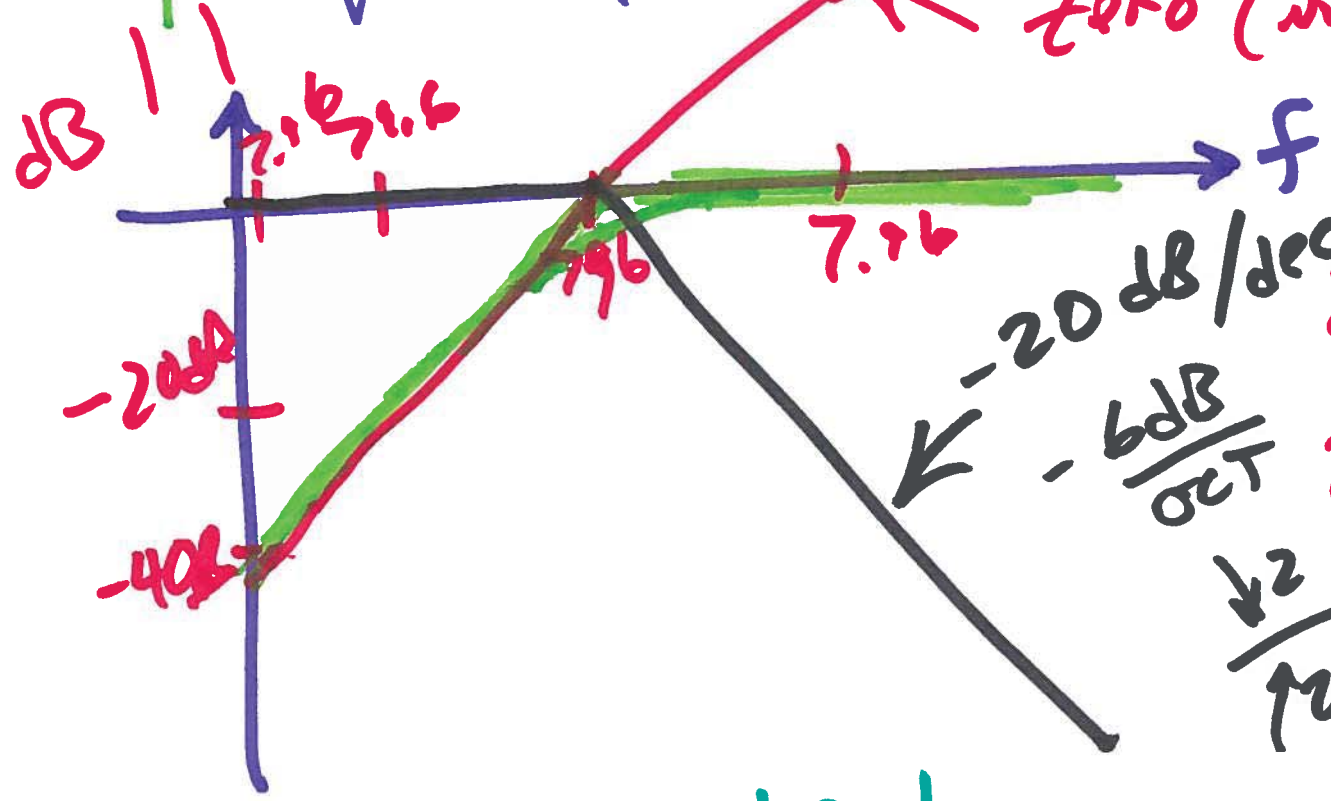
$$\frac{f}{796}$$

$$\sqrt{1 + \left(\frac{f}{796}\right)^2}$$

$$\angle_{2\omega} = 90^\circ -$$

$$\frac{100 \text{ dB}}{\text{dec}} \text{ term}^{-1} \frac{f}{796}$$

zero (unwanted)



-20 dB/dec  
-6 dB/oct

$$20 \log 1 = 0$$

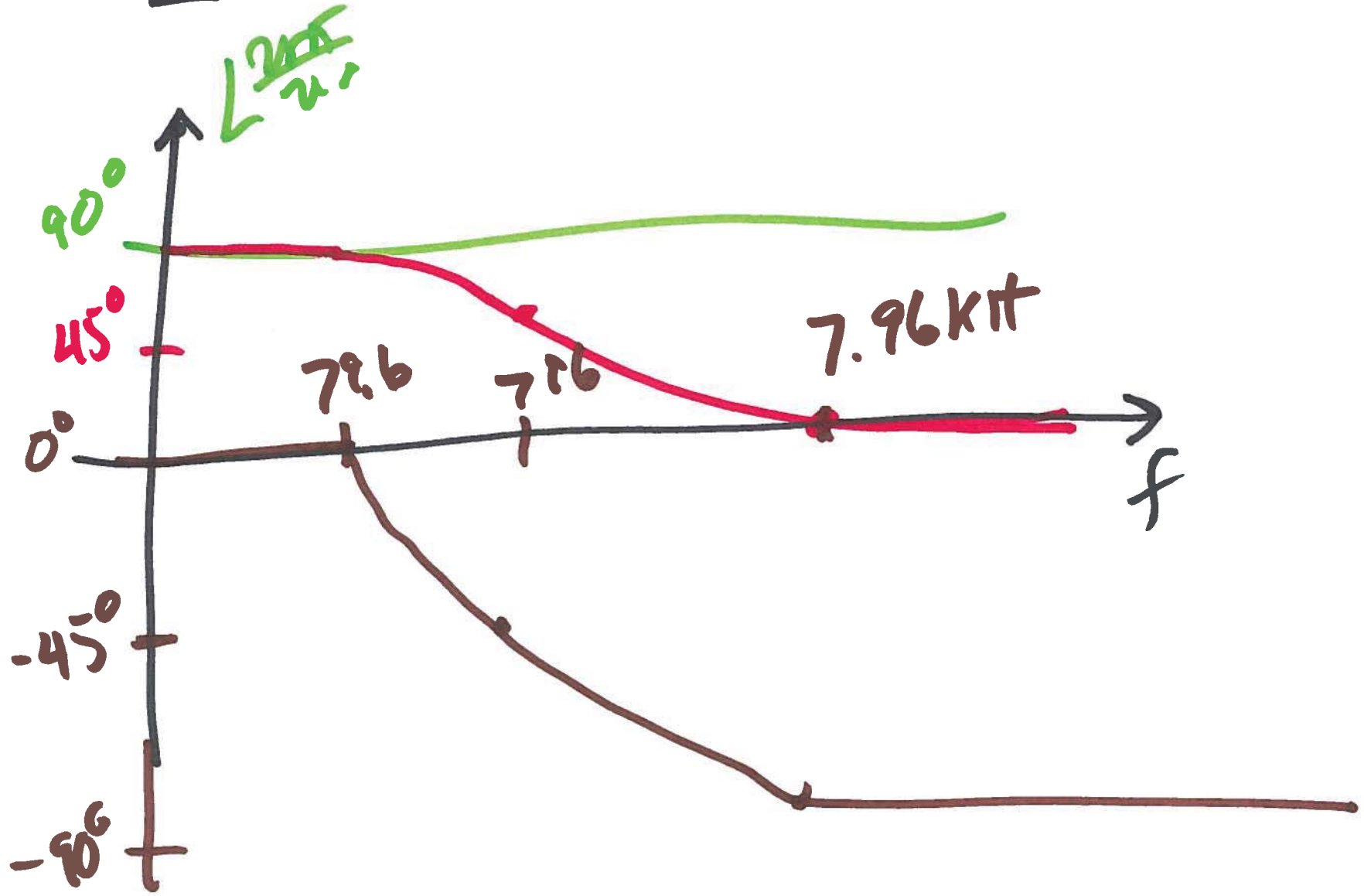
$$20 \log \frac{7.96 \text{ kHz}}{796}$$

$$\frac{1}{f^2} = 20 \text{ dB}$$

$$20 \log \left| \frac{a}{b} \right| = 20 \log a + 20 \log \frac{1}{b}$$

6)

$$\angle \frac{200s}{2s+1} = 90^\circ - \tan^{-1} \frac{f}{796}$$



⇒