EE 221 circuits II

May 6, 2019

Lecture 25

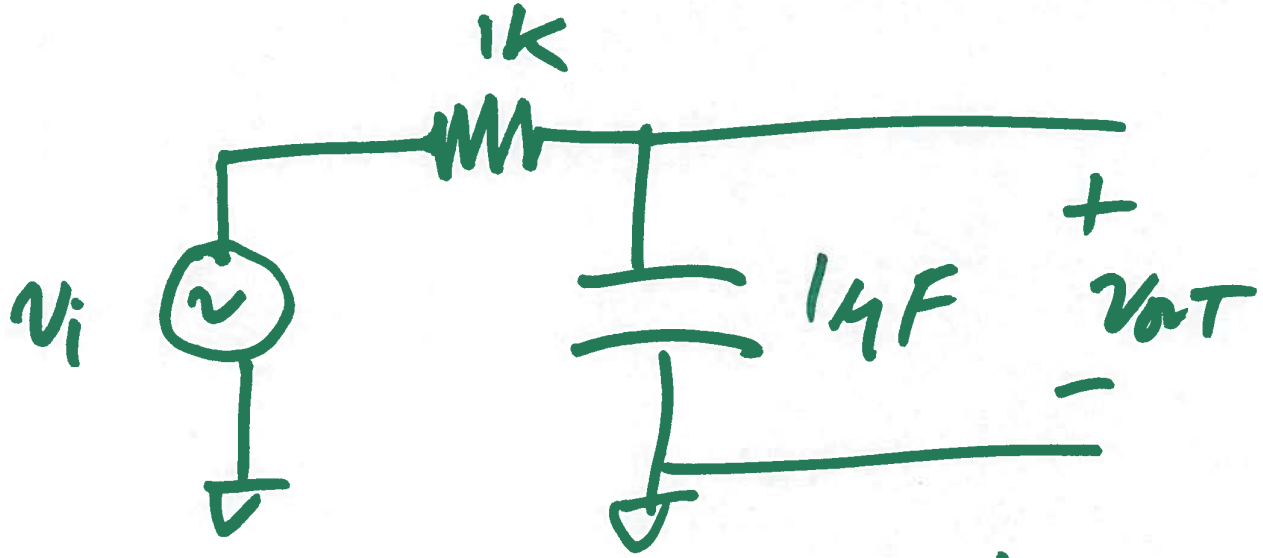
$\frac{1}{s+a} \rightarrow e^{-at}$

$u(t) \leftrightarrow \frac{1}{s}$

$u(t-t_0) \rightarrow \frac{e^{-t_0 \cdot s}}{s}$

$A \cdot e^{-t/\tau} \rightarrow \frac{A}{s + \frac{1}{\tau}}$

$A \cdot e^{\frac{-(t-t_0)}{\tau}} \rightarrow \frac{A e^{-t_0 \cdot s}}{s + \frac{1}{\tau}}$



transfer function,

$$\frac{v_{out}}{v_i} = \frac{\frac{1}{j\omega C}}{\frac{1}{j\omega C} + R} = \frac{1}{1 + j\omega RC}$$

$$\left|\frac{v_{out}}{v_{in}}\right| = \frac{1}{\sqrt{1 + (\omega RC)^2}}$$

2)

$$\left|\frac{v_{out}}{v_{in}}\right| = \frac{1}{\sqrt{1+(2\pi f RC)^2}} \rightarrow f_{3dB} = \frac{1}{2\pi RC}$$

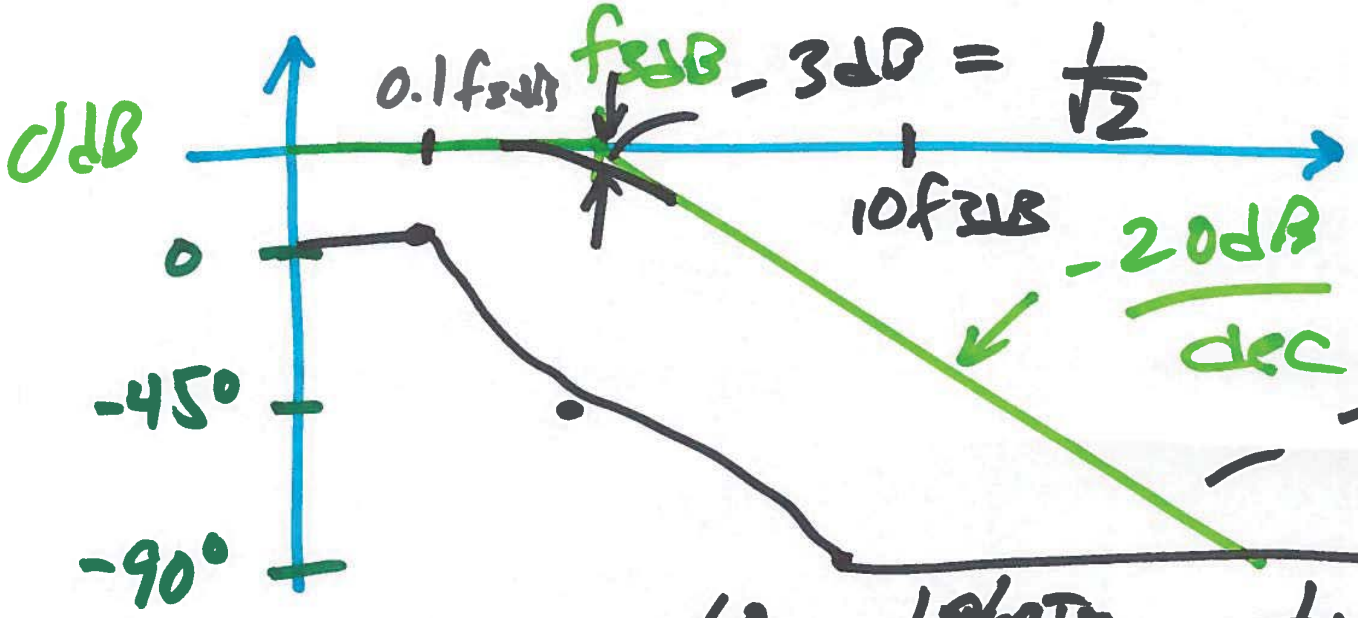
$$\frac{1}{2\pi \cdot 10^3 \cdot 10^{-6}} = \frac{1}{2\pi \cdot 10^{-3}}$$

$$= \frac{1}{0.00628} = 159\,Hz$$

$$\frac{1}{\sqrt{1+\left(\frac{f}{f_{3dB}}\right)^2}}$$

, $f \gg f_{3dB}$

$$\approx \frac{f_{3dB}}{f}$$



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

UNLV | ELECTRICAL & COMPUTER ENGINEERING

CMOSedu.com

3)

Phase Shift

$$\theta = \frac{t_d}{T} \cdot 360 = t_d \cdot f \cdot 360^\circ$$

$$f = \frac{1}{T}$$

$$\frac{V_{out}}{V_{in}} = \frac{1 + j0}{1 + j 2\pi f RC}$$

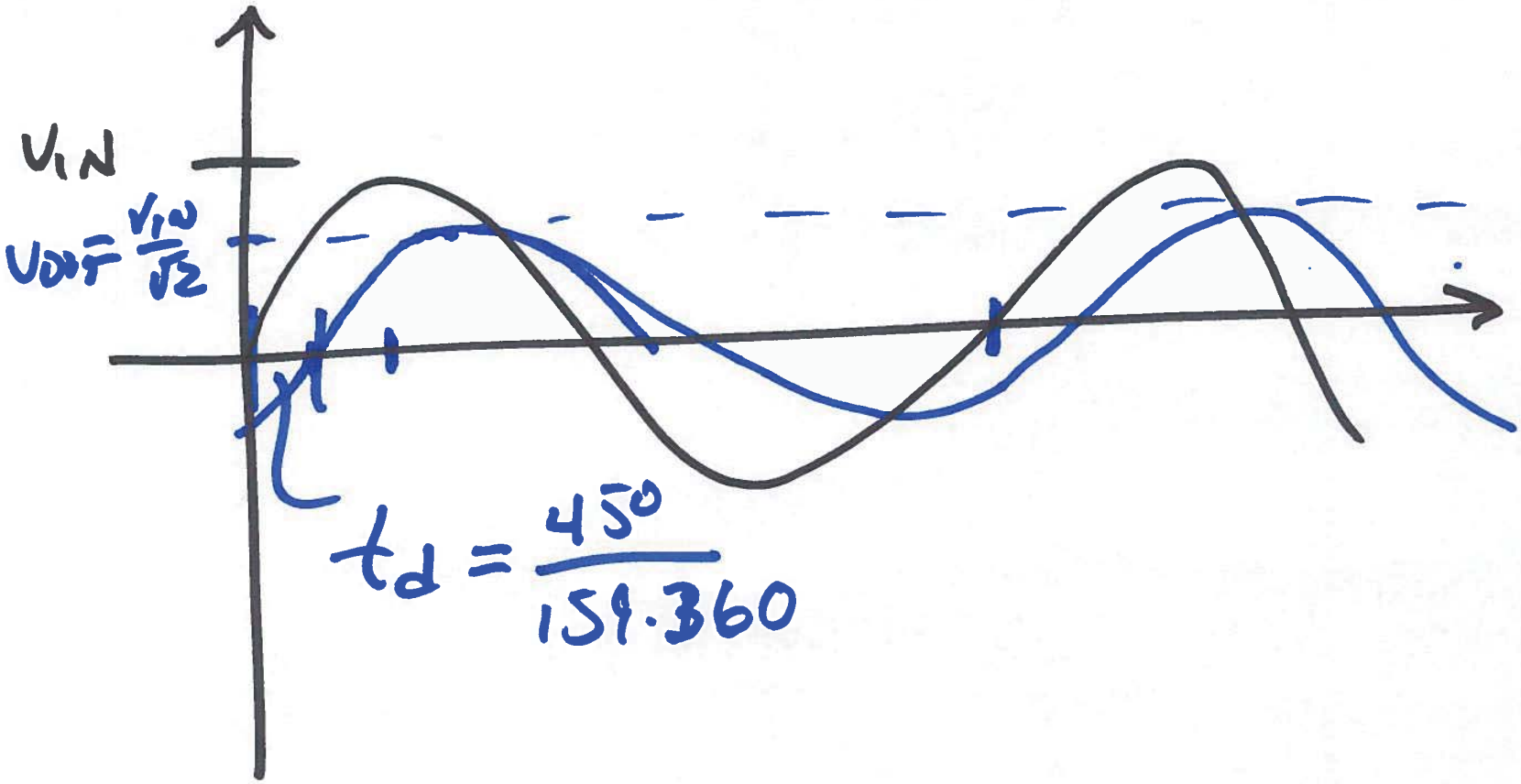
$$\angle \frac{V_{out}}{V_{in}} = \tan^{-1}\frac{0}{1} - \tan^{-1} 2\pi f RC$$

$$= -\tan^{-1}\frac{f}{f_{3dB}}$$

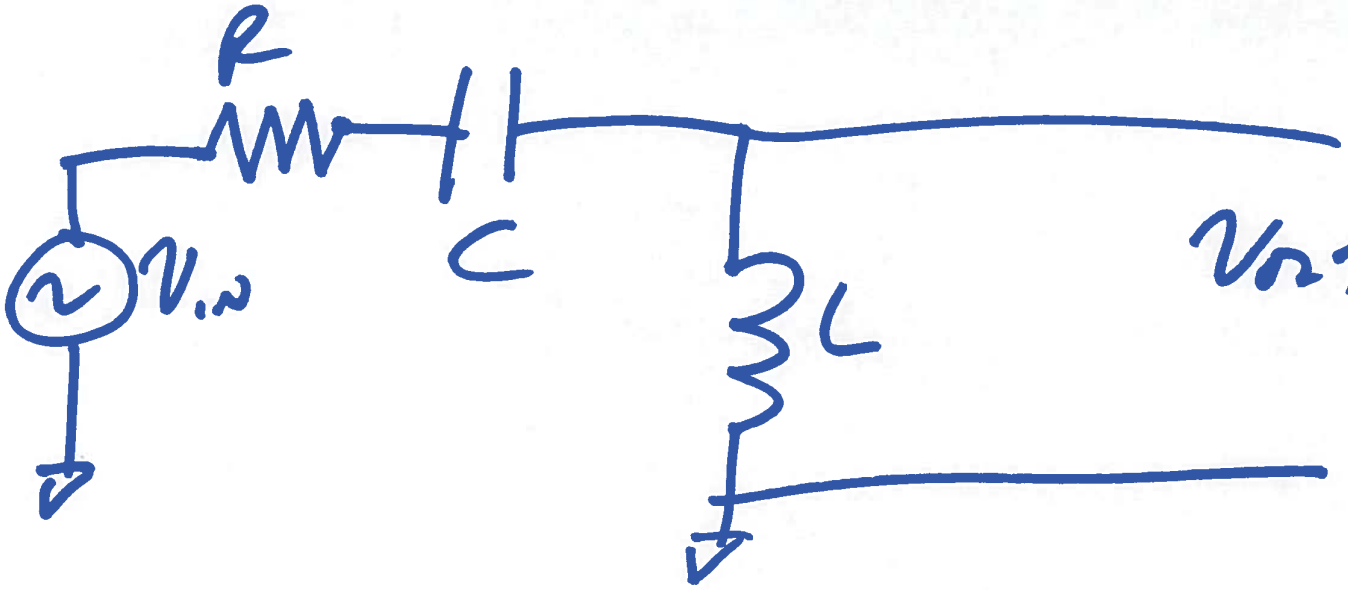
$$-\tan^{-1} 0 = 0$$

$$-\tan^{-1} 1 = -45^\circ$$

$$-\tan^{-1}\infty = -90$$



5)

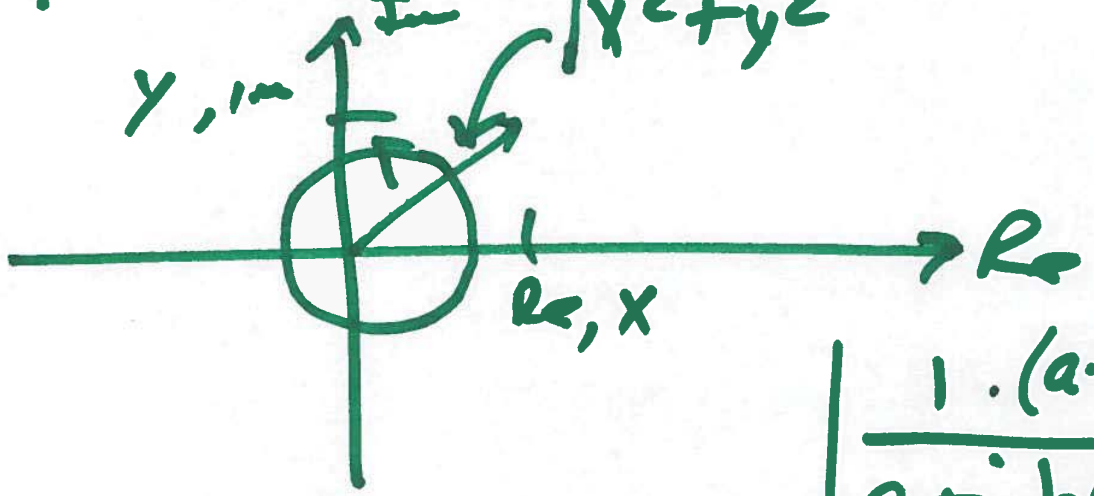


$$\frac{V_{out}}{V_{in}} = \frac{sL}{sL + \frac{1}{sC} + R} = \frac{s^2LC}{s^2LC + 1 + sRC}$$

$$\frac{V_{out}}{V_{in}} = \frac{s^2}{s^2 + s\cdot\frac{R}{L} + \frac{1}{LC}}$$

$s^2 \rightarrow (0+j\omega)(0+j\omega)$

$|s^2| = \sqrt{0^2+(\omega^2)} \cdot \sqrt{0^2+\omega^2}$



$|s^2| = \omega^2$

$\left|\frac{1 \cdot (a-jb)}{a+jb(a-jb)}\right|$

$\left|\frac{1}{\sqrt{a^2+b^2}}\right|$

7)

$$\left|\frac{V_{OUT}}{V_{IN}}\right| = \left|\frac{s^2}{s^2 + s\cdot\frac{R}{L} + \frac{1}{LC}}\right|$$

$$s_{1,2} = \frac{-\frac{R}{L} \pm \sqrt{\left(\frac{R}{L}\right)^2 - \frac{4R}{LC}}}{2}$$

$$\left|\frac{V_{OUT}}{V_{IN}}\right| = \left|\frac{s^2}{(s - s_1)(s - s_2)}\right|$$

10^3 10^4

$$= \frac{\omega^2}{\sqrt{(10^3)^2 + (\omega)^2}\cdot\sqrt{(10^4)^2 + (\omega)^2}}$$

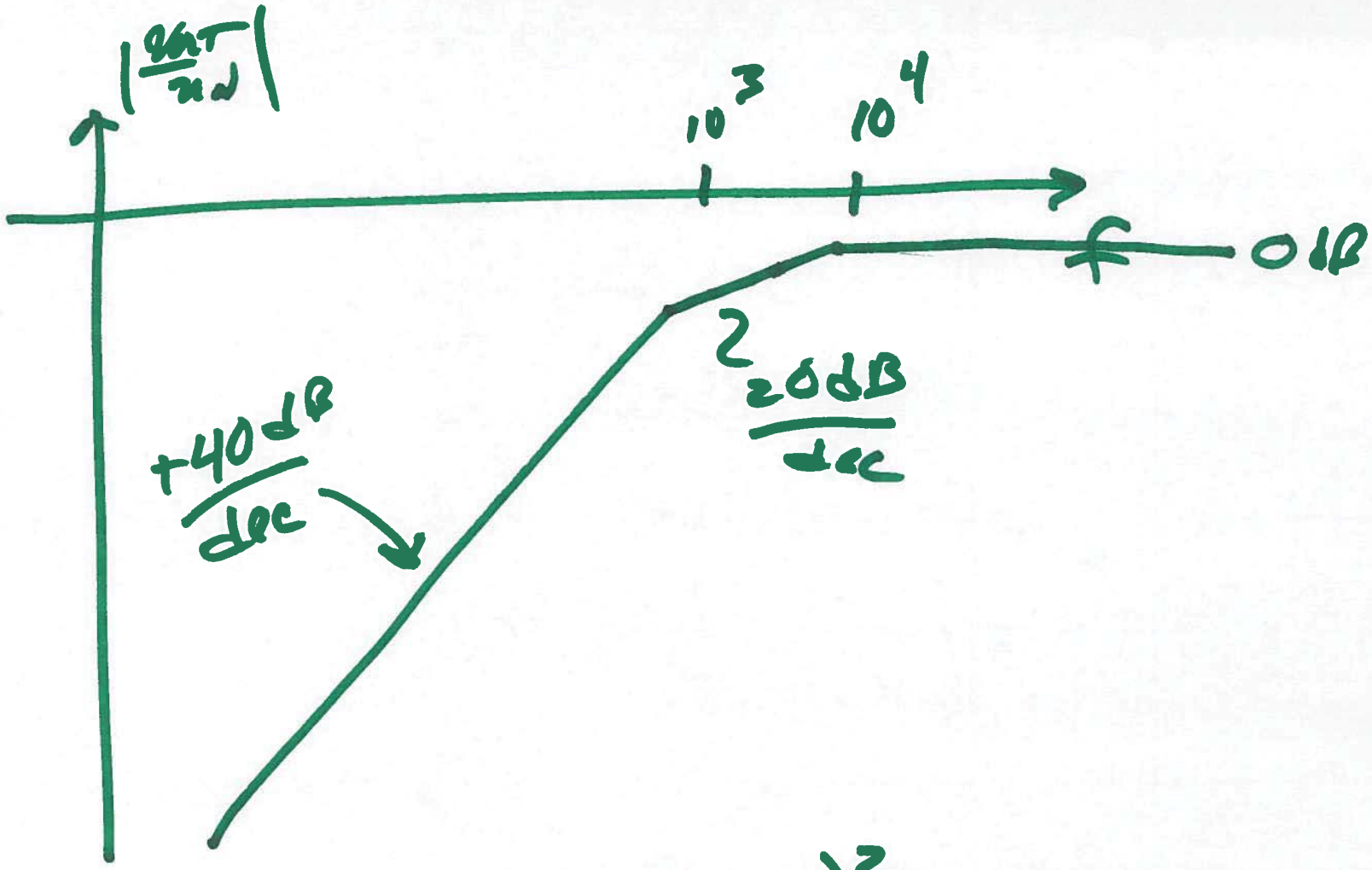
$$\left|\frac{v_{out}}{v_{in}}\right| = \left|\frac{s^2}{(-s_1)(-s_2)\left(1+\frac{s}{s_1}\right)\left(1+\frac{s}{s_2}\right)}\right|$$

$$= \frac{\omega^2}{\sqrt{\left(\frac{\omega}{s_1}\right)^2+1^2}\cdot\sqrt{1^2+\left(\frac{\omega}{s_2}\right)^2}}$$

$\omega = 2\pi f$

$s_1 = 2\pi\cdot 10^3$, $s_2 = 2\pi\cdot 10^4$

$$= \frac{\omega^2}{\sqrt{1+\left(\frac{f}{10^3}\right)^2}\cdot\sqrt{1+\left(\frac{f}{10^4}\right)^2}}$$



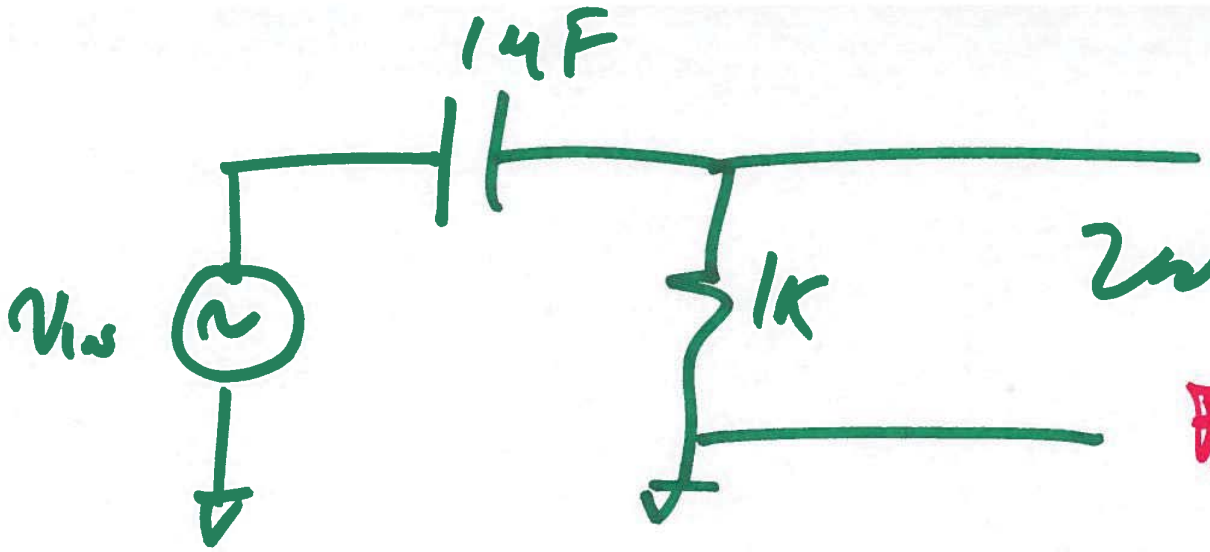
$20\log(2\pi f)^2$ $\quad 10 \cdot 40 \log 6.28$

$40 \log 2\pi \cdot f$

$40 \log 6.28$

$f=1 \rightarrow$

$f=10 \rightarrow 40 \log 6.28 \cdot 10$



$$S = \sigma + j\omega$$

$$\frac{S \cdot 10^{-3}}{1 + S \cdot 10^{-3}}$$

$$\frac{V_{out}}{V_{in}} = \frac{10^{3}}{10^{3} + \frac{1}{j \cdot \omega \cdot 10^{-6}}}$$

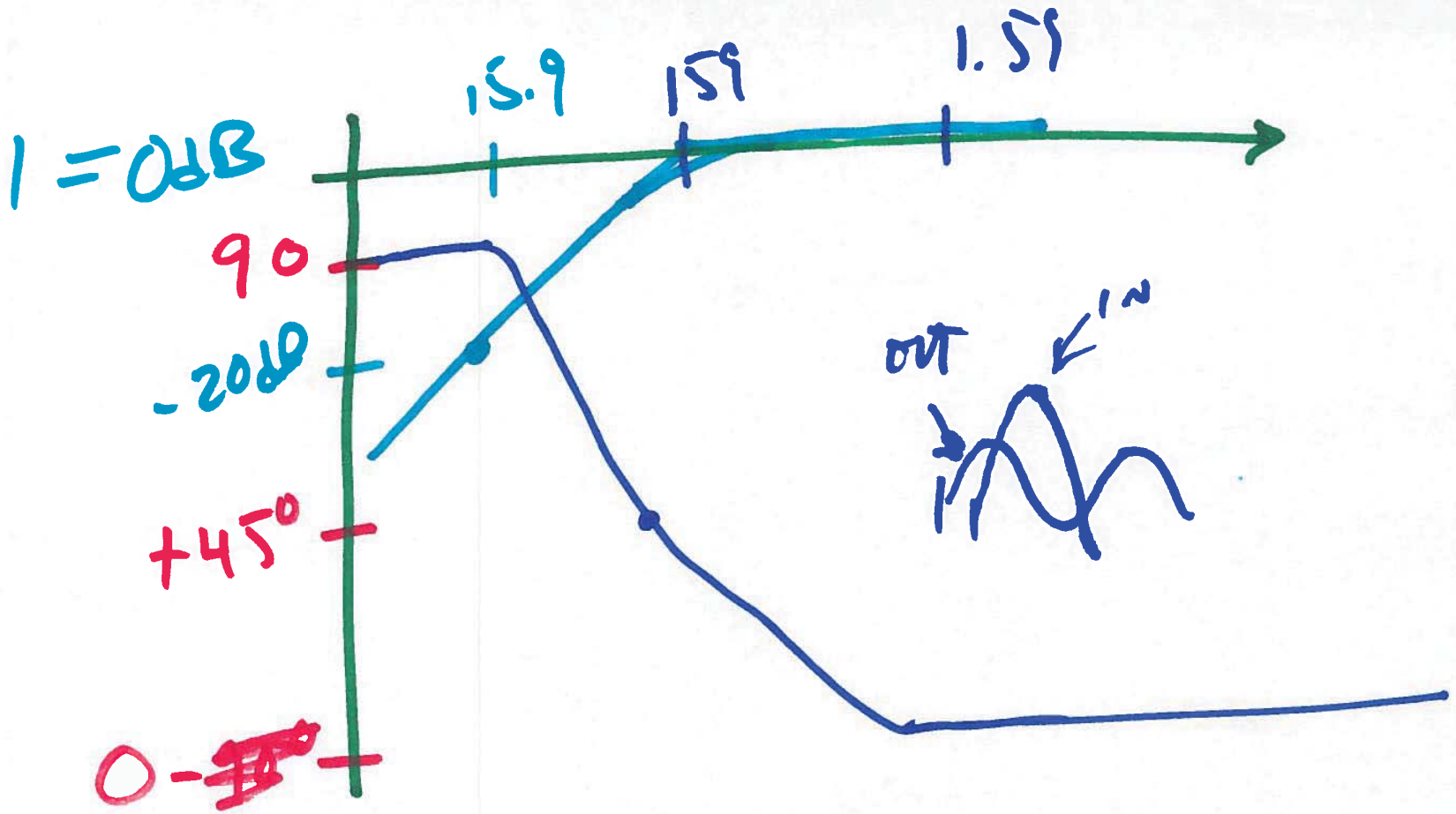
$$\frac{V_{out}}{V_{in}} = \frac{j\omega \cdot 10^{-3}}{1 + j\omega 10^{-3}}$$

11)

$$\frac{V_{OUT}}{V_{IN}} = \frac{0 + j\frac{f}{159}}{1 + j\frac{f}{159}} \qquad f \gg 159$$

$$\left|\frac{V_{OUT}}{V_{IN}}\right| = \frac{\sqrt{0^2 + \left(\frac{f}{159}\right)^2}}{\sqrt{1 + \left(\frac{f}{159}\right)^2}} = \frac{\frac{f}{159}}{\sqrt{1 + \left(\frac{f}{159}\right)^2}} \to 1$$

$$\angle\frac{V_{OUT}}{V_{IN}} = \tan^{-1}\frac{f}{\frac{159}{0}} - \tan^{-1}\frac{f}{159} \to 90$$



$$\angle \frac{V_{OUT}}{V_{IN}} = 90 - \tan^{-1}\frac{f}{159}$$