EE 221 Circuits II

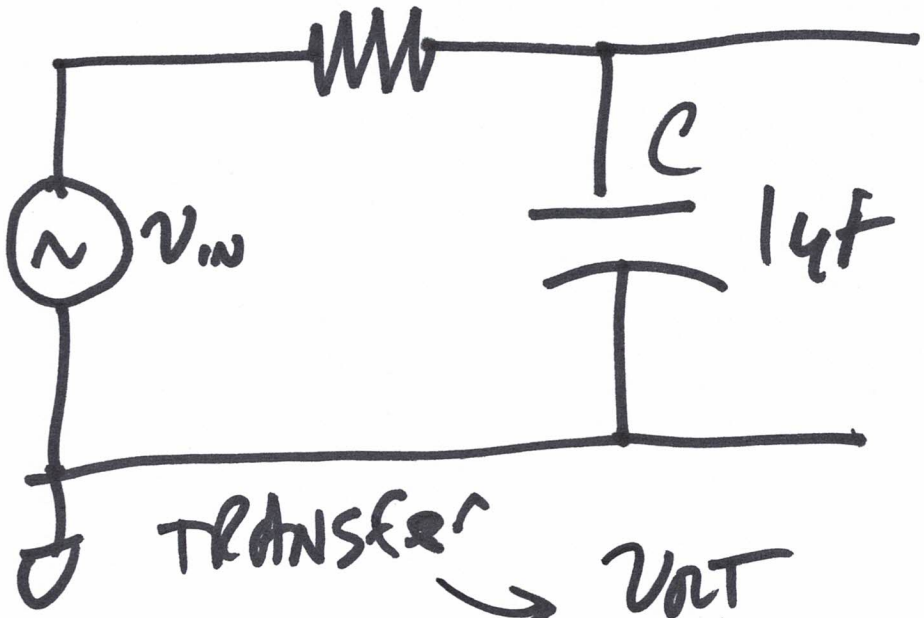
$\frac{i}{v}$

$\frac{V_{OUT}}{i_{IN}}$

Lecture 11

1K, R

MARCH 2, 2020



$$V_{OUT} = V_{IN} \cdot \frac{\frac{1}{jwC}}{\frac{1}{jwC} + R}$$

TRANSFER → $\frac{V_{OUT}}{V_{IN}} = \frac{1}{1 + jwRC}$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+j2\pi fRC} = \frac{1}{1+j\frac{f}{\frac{1}{2\pi RC}}}$$

$$= \frac{1}{1+j\frac{f}{f_{3dB}}}, \quad f_{3dB} = \frac{1}{2\pi RC}$$

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

$$= 159\,Hz$$

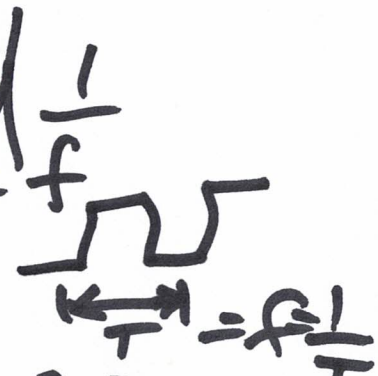
$$\frac{V_{out}}{V_{in}} = \frac{1}{1+j\frac{f}{159}}$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{1}{\sqrt{1+\left(\frac{f}{159}\right)^2}}, \quad \angle\frac{V_{out}}{V_{in}} = -\tan^{-1}\frac{\frac{f}{159}}{1}$$

$$= -\tan^{-1}\frac{f}{159}$$

2)

$$dB = 20 \log \frac{V_{out}}{V_{in}}$$



$s = j\omega = 2\pi f$

$1 \rightarrow 0\ dB$

@ 300 Hz $\left|\frac{V_{out}}{V_{in}}\right| = -6.5\ dB$

$\angle \frac{V_{out}}{V_{in}} = -61°$

$-6.5 = 20 \log \frac{V_{out}}{V_{in}}$

$61° = 360 \cdot \frac{t_d}{T}$

$\frac{V_{out}}{V_{in}} = 10^{-6.5/20}$

$= 0.47$

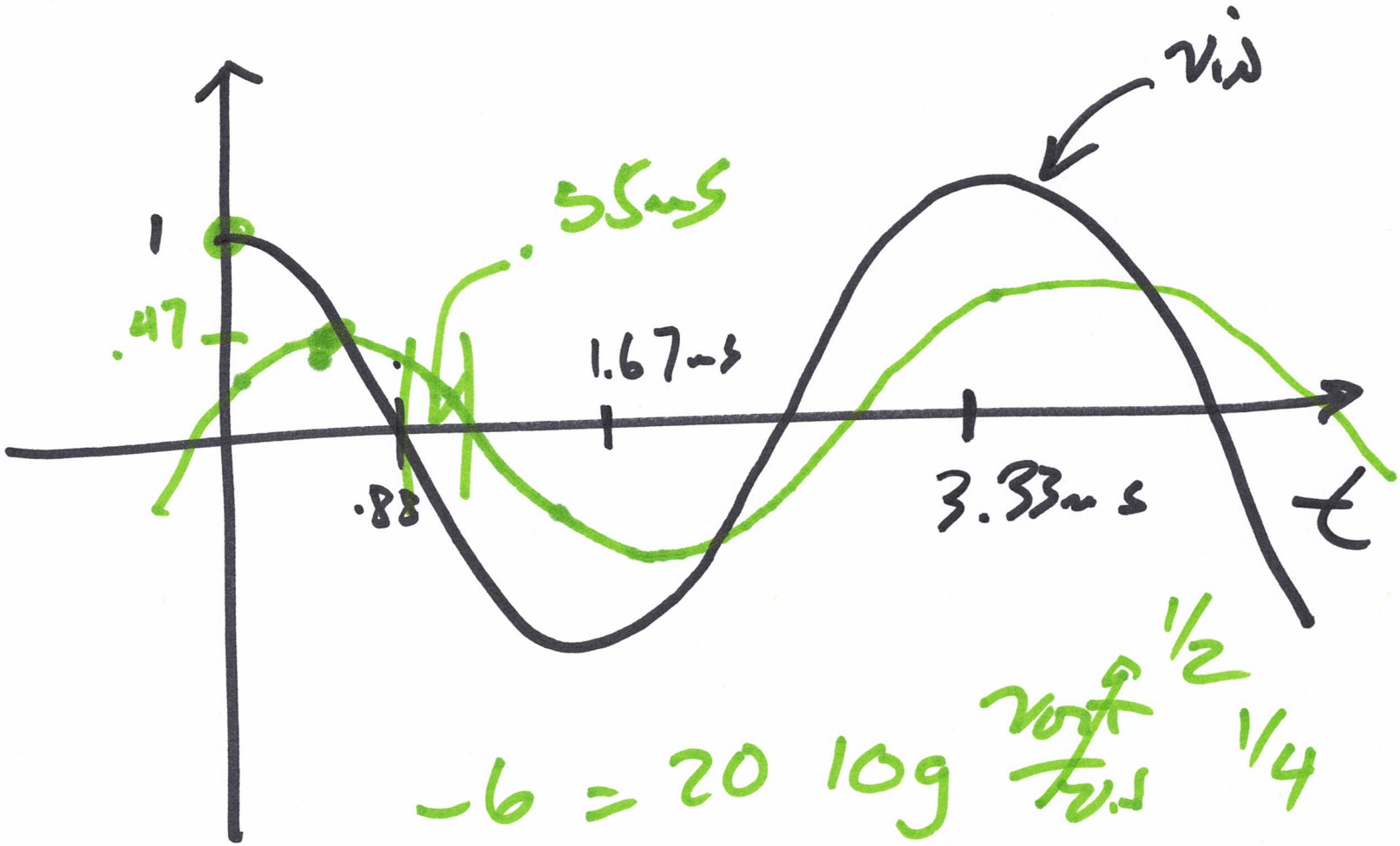
$= 360 \cdot t_d \cdot f$ (300)

$t_d = \frac{60}{360} \cdot \frac{1}{300}$

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

$t_d = 0.55\ ms$

3)



$$-6 = 20 \log \frac{v_{out}}{2.5}^{1/2}$$

$$\frac{v_{out}}{2.5}^{1/4}$$

$$\frac{v_{out}}{2.5} = 10^{-6/20} = \frac{1}{2}$$

4)

$$\frac{v_{nT}}{v_{iN}} = \frac{1}{1 + j\frac{f}{f_{3dB}}}$$

Frenzel Euler

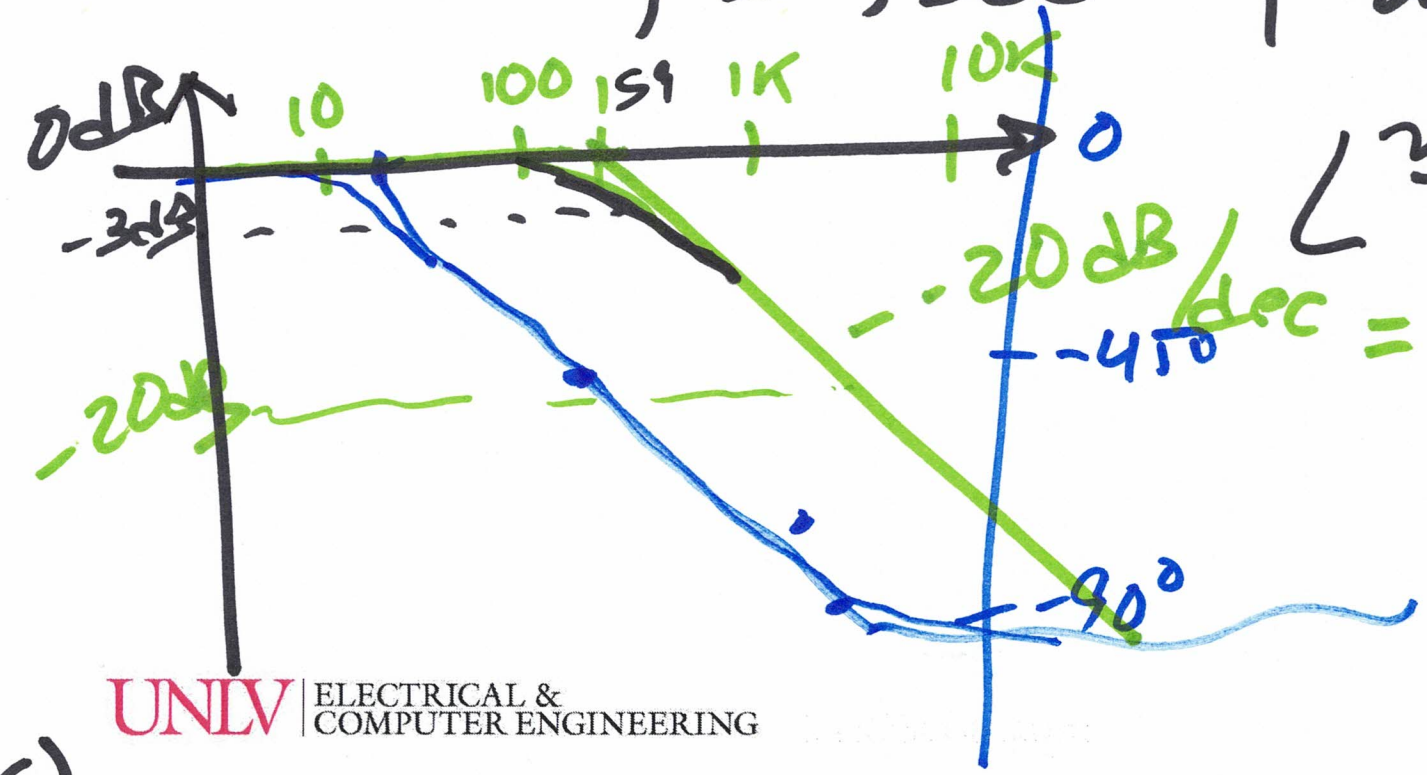
Bode Plot

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

$f_{3dB} \rightarrow 159$

$f = f_{3dB}$

$$\left|\frac{v_{nT}}{v_{iN}}\right| = \frac{1}{\sqrt{2}}$$

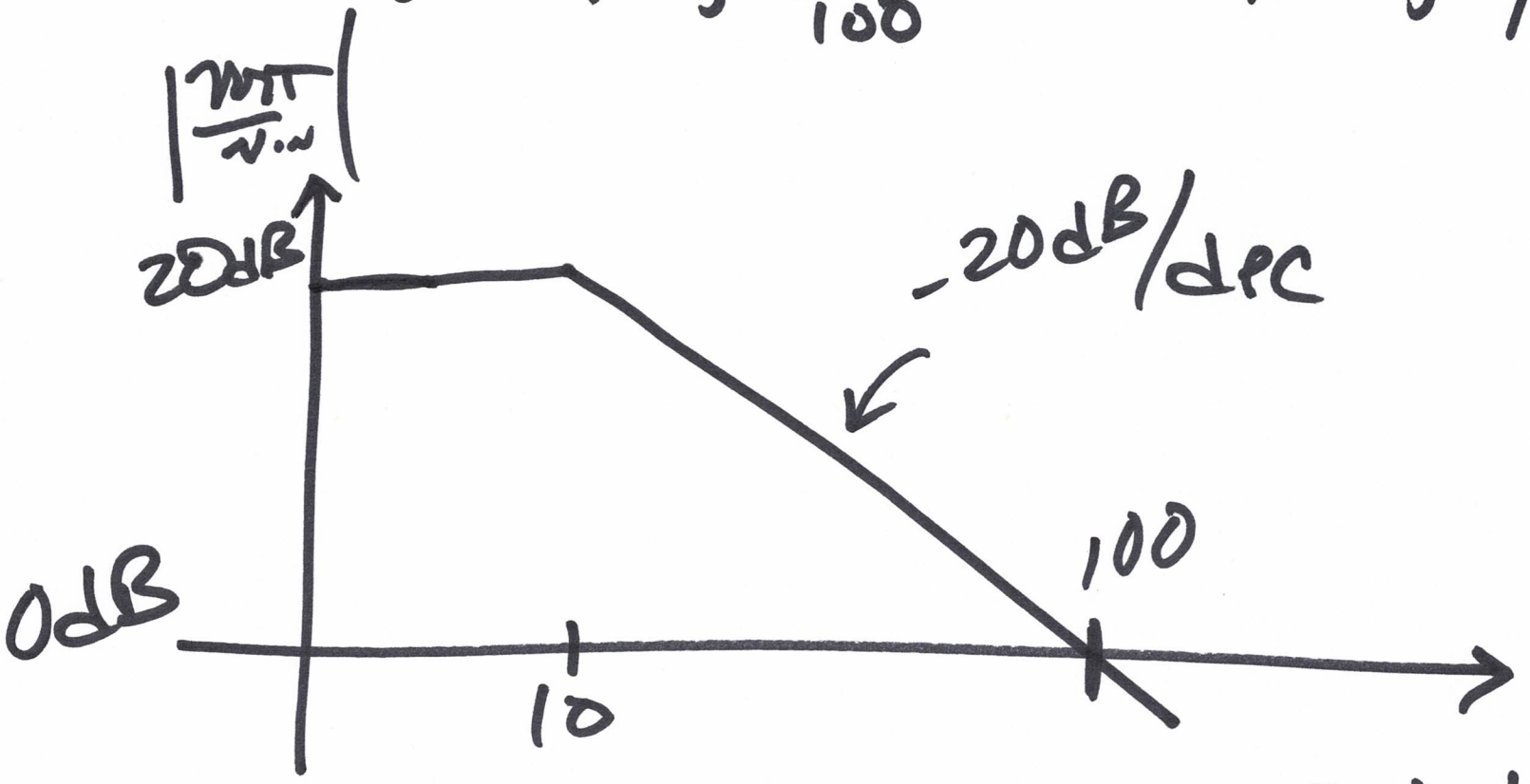


$$\angle \frac{v_{nT}}{v_{iN}} = -\tan^{-1}\frac{f_{3dB}}{f_{3dB}}$$

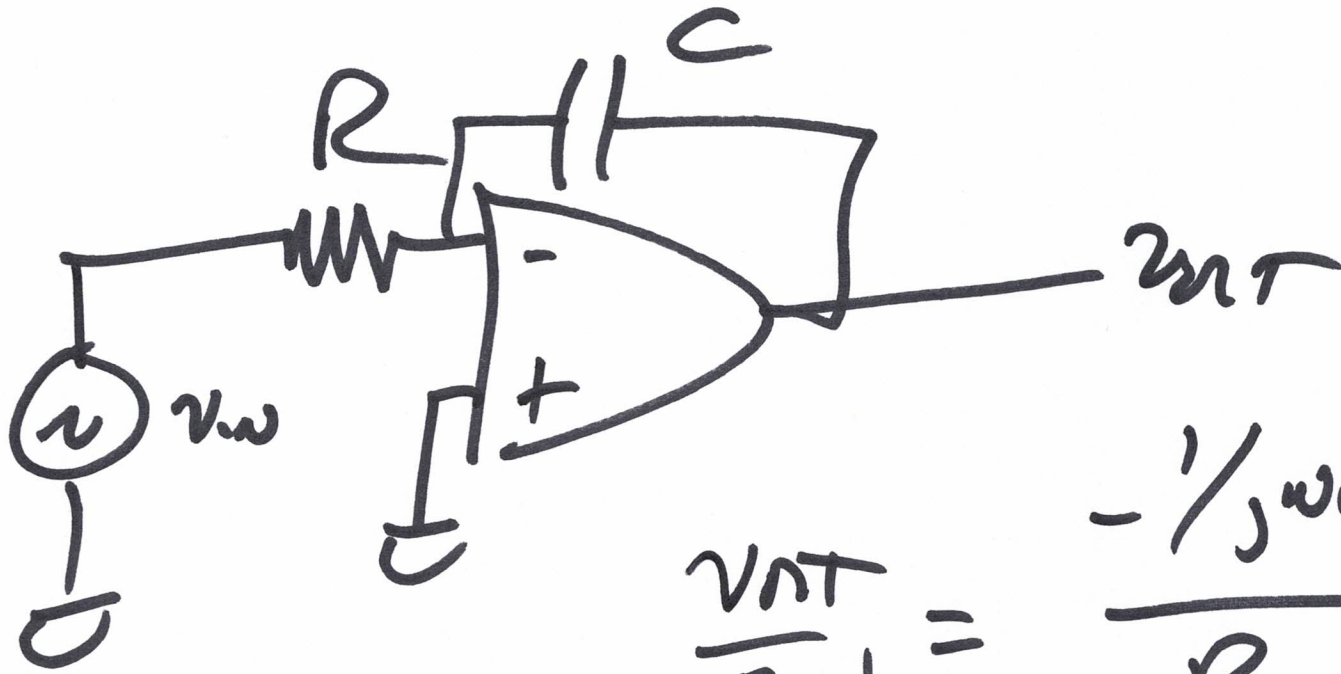
$-20\,dB/dec = -6\,dB/oct$

$= -45°$

$$\frac{V_{OUT}}{V_{IN}} = \frac{1}{0.1 + j\frac{f}{100}} = \frac{10}{1 + j\frac{f}{10}}$$



$$20 \log 10 = 20\,dB$$

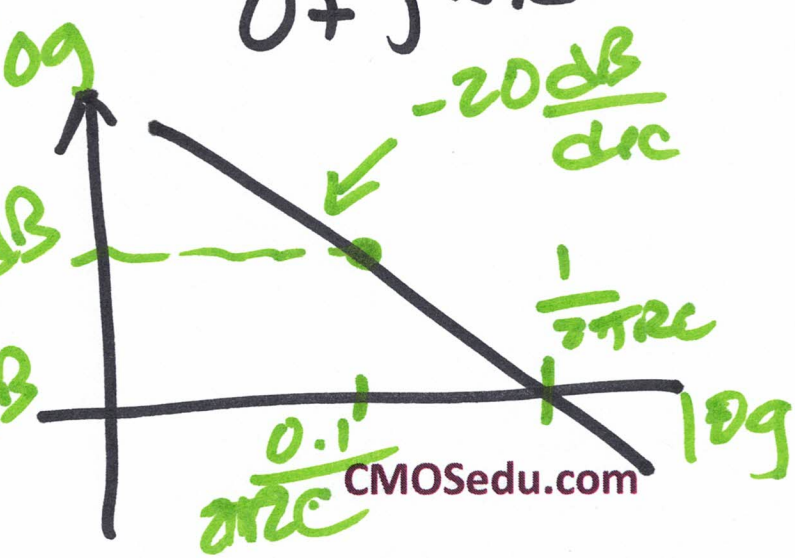


$$\frac{v_{OUT}}{v_{IN}} = \frac{-1/j\omega C}{R}$$

$$\left|\frac{v_{OUT}}{v_{IN}}\right| = \frac{1}{\sqrt{0^2 + (2\pi f RC)^2}} = \frac{-1}{0 + j\omega RC}$$

$$= \frac{1}{2\pi f RC}$$

$$10 = \frac{1}{2\pi f_C R} \cdot \frac{0.1}{2\pi f_C C}$$



7)

$$|1| = \frac{1}{0.37 \cdot f}$$

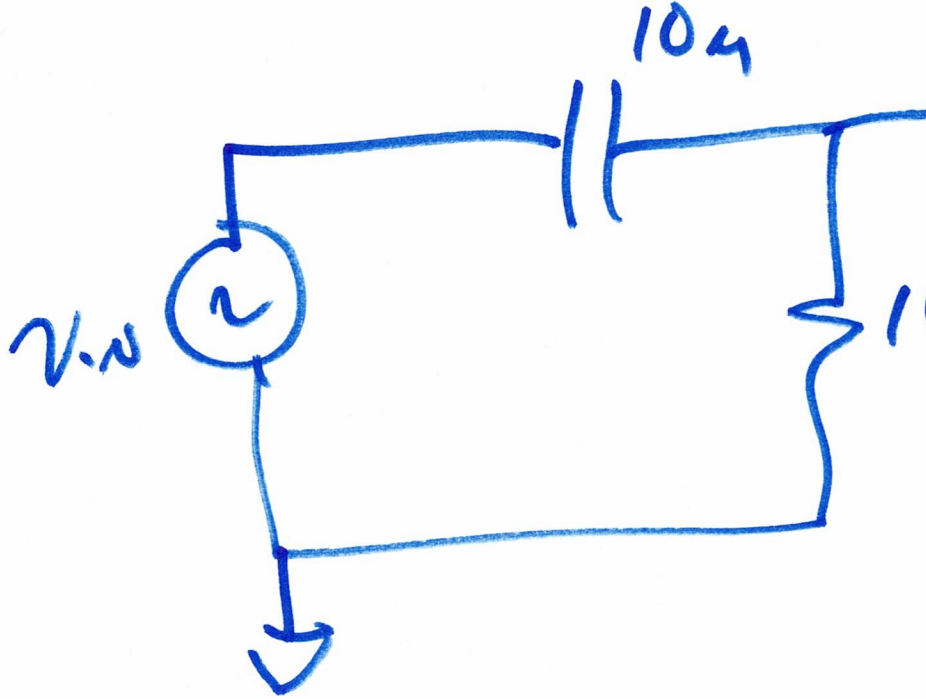
$$f = \frac{1}{0.37} \rightarrow |1| = 1$$

$$f = \frac{10}{0.37} \rightarrow |1| = \frac{1}{10}$$

up in freq one dec

$\frac{1}{f}$

$$\frac{-20\,dB}{dec} = \frac{\nearrow 10}{\searrow 10} \; -20\,dB$$



$$v_{out} = \frac{100 \cdot v_{in}}{100 + \frac{1}{j\omega \cdot 10^{-5}}}$$

$$\frac{v_{out}}{v_{in}} = \frac{100 \cdot j\omega 10^{-5}}{1 + j\omega \cdot 10^{-5} \cdot}$$

$$\frac{v_{out}}{v_{in}} = \frac{0 + j \cdot 2\pi f \cdot 10^{-3}}{1 + j\,2\pi f \cdot 10^{-3}}$$

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

9)

$$\angle \frac{V_{out}}{V_{in}} = \underbrace{\tan^{-1}\frac{2\pi f \cdot 10^{-3}}{0}}_{90^\circ} - \tan^{-1}\frac{2\pi f \cdot 10^{-3}}{1}$$

$$f_{3dB} = \frac{1}{2\pi \cdot 10^{3}} = 154$$