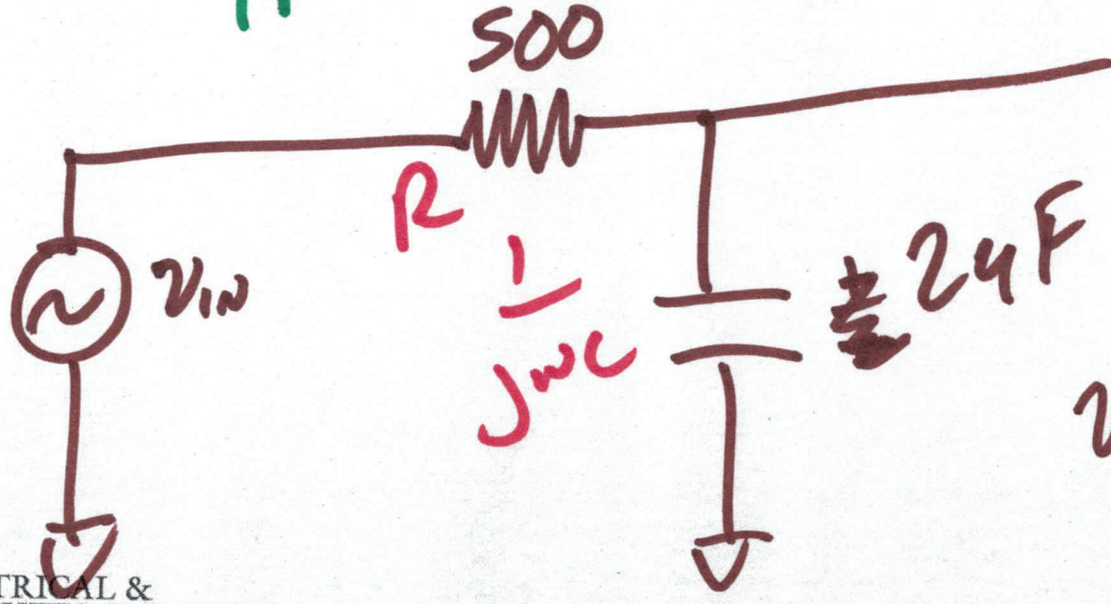
EE 221 Circuits II

MARCH 3, 2021

Lecture 12

$\frac{V_{OUT}}{V_{IN}} = \frac{\frac{1}{j\omega C}}{\frac{1}{j\omega C} + R}$

1PM Sunday MARCH 7, 2021



det. freq. resp.

$V_{OUT} = ?$ at 200 Hz

$$\frac{v_{out}}{v_{in}} = \frac{1}{1 + j 2\pi f \cdot RC} = \frac{1}{1 + j \frac{f}{\frac{1}{2\pi RC}}}$$

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

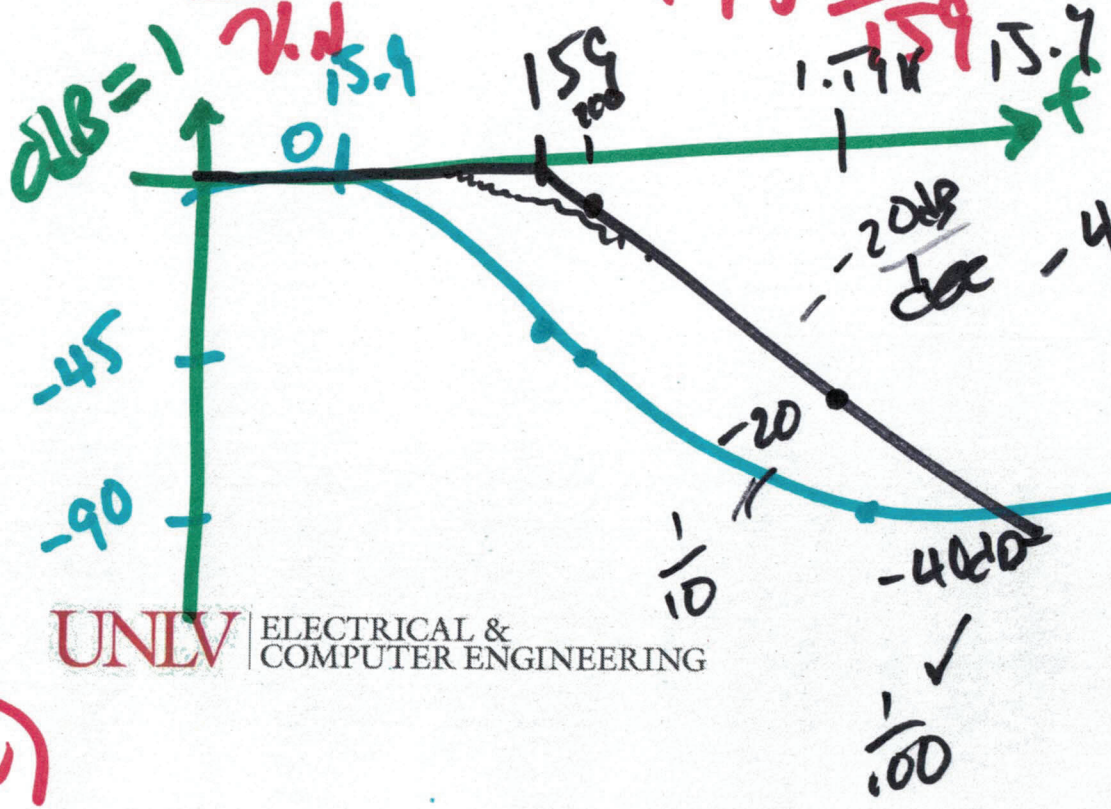
$$10^{\frac{-4}{20}} = \frac{v_{out}}{v_{in}} \quad .6$$

$$f_{3dB} = \frac{1}{2\pi RC} = \frac{1}{2\pi \cdot 500 \cdot .2\mu F}$$

$$= 159 Hz$$

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

$$\left|\frac{v_{out}}{v_{in}}\right| = \frac{1}{\sqrt{1 + \left(\frac{f}{159}\right)^2}}$$



$$\angle \frac{v_{out}}{v_{in}} = -\tan^{-1} \frac{f}{159}$$

→ x10 x2

↓ 10 ↓ 2 (-4dB)

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2)

$$\left|\frac{V_{out}}{V_{in}}\right| = 0.6 \qquad \angle\frac{V_{out}}{V_{in}} = -50^\circ$$

$$v_{out} = 0.6\sin(\pi \cdot 200 \cdot t - 50)\Big|_{v_{in}=1}$$

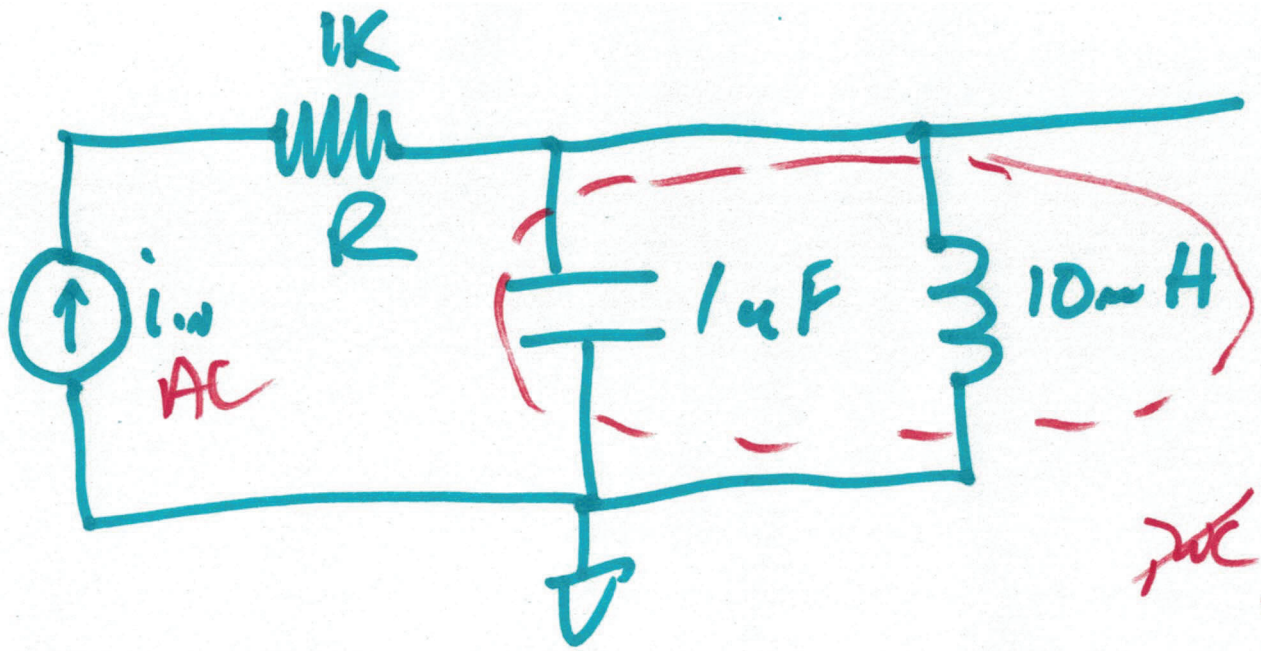
$f = 200\,Hz \rightarrow T = 5\,ms$

$$-\frac{50}{360} \cdot 5\,ms = \Delta t$$

$$\Delta t \simeq .7\,ms$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{1}{2}$$

$$20\log\frac{1}{2} = -6\,dB$$



$$Z_i = 2_{out}$$

$$s = j\omega + \sigma$$

$$\frac{V_{out}}{i_{in}} = Z_1$$

$$Z = \frac{\frac{1}{j\omega C} \cdot j\omega L}{\frac{1}{j\omega C} + j\omega L}$$

$$= \frac{j\omega L}{1 + (-1)\omega^2 LC}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$\frac{v_{OUT}}{i_{IN}} = \frac{j\omega L}{1-\omega^2 LC} \longrightarrow$$

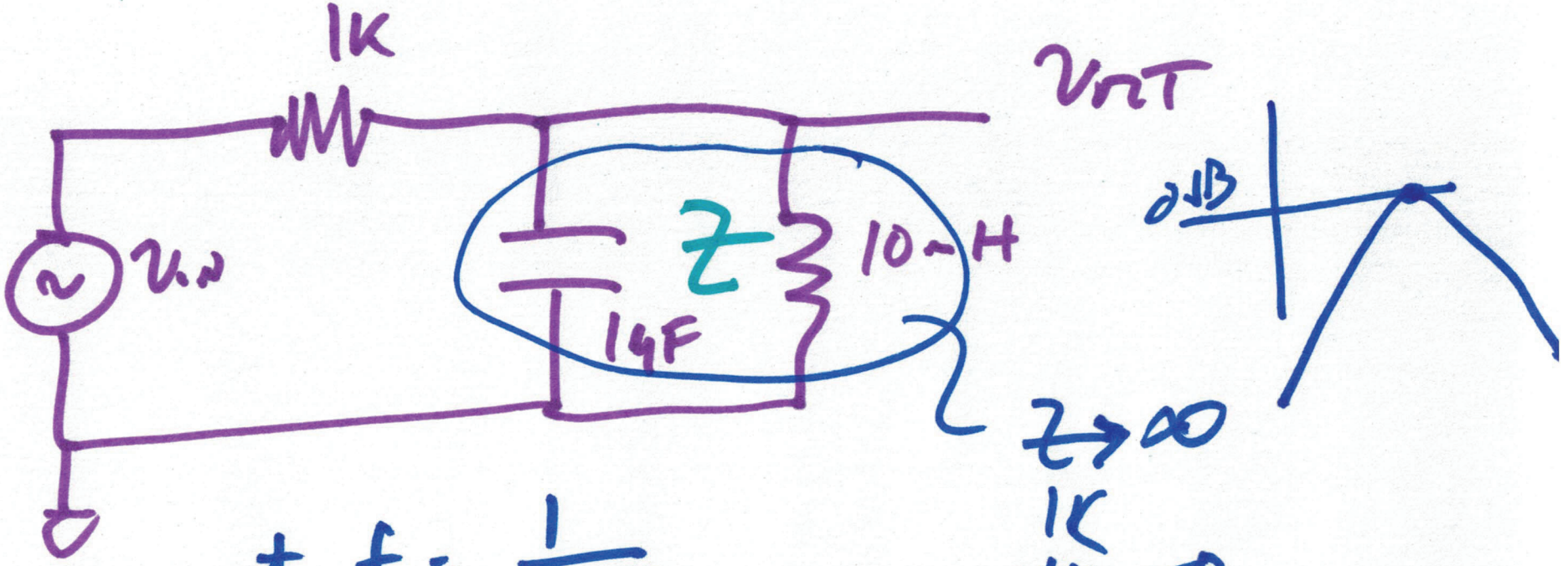
$$\angle \frac{v_{OUT}}{i_{IN}} = \tan^{-1}\frac{\omega L}{0} - \tan^{-1}\frac{0}{1-\omega^2 LC}$$

(annotations: $\frac{\omega L}{0} \to \infty$, $\frac{0}{1-\omega^2 LC} \to 0$)

$$= 90 - 0 = 90^{\circ}$$

$$= \sqrt{0^2 + (\omega L)^2} \cdot \frac{1}{\sqrt{(1-\omega^2 LC)^2 + 0^2}}$$

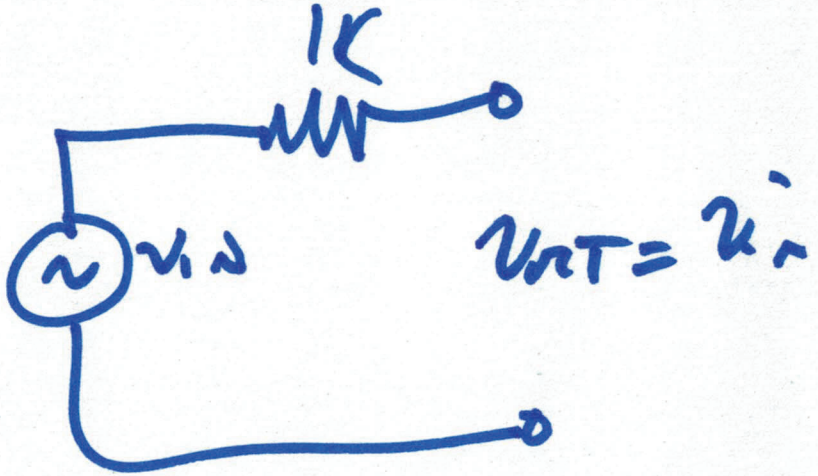
$$= \frac{\omega L}{1-\omega^2 LC}$$



$$Z = \frac{\frac{1}{j\omega C} \cdot j\omega L}{\frac{1}{j\omega C} + j\omega L}$$

at $f = \frac{1}{2\pi\sqrt{LC}}$

$Z \to \infty$



$$Z = \frac{j\omega L}{1 - \omega^2 LC}$$

$$\frac{V_{out}}{V_{in}} = \frac{Z}{Z + 1K} = \frac{j\omega L}{j\omega L + 1K - \omega^2 LC}$$

$$\frac{V_{out}}{V_{in}} = \frac{j \cdot 2\pi \cdot 0.01 f}{j \cdot 2\pi \cdot 0.01 f + 1{,}000 - (2\pi f)^2 \cdot 10^3 \cdot 10^{-6} \cdot 10^{-2}}$$

$$= \frac{j 2\pi \cdot 0.01 \cdot f}{j 2\pi \cdot 0.01 \cdot f + 1{,}000 - (2\pi f)^2 \cdot 10 \cdot 10^{-6}}$$

$$0 = 1{,}000 - (2\pi f)^2 \cdot 10 \cdot 10^{-6}$$

$$(2\pi f)^2 \cdot 10 \cdot 10^{-6} = 1{,}000$$

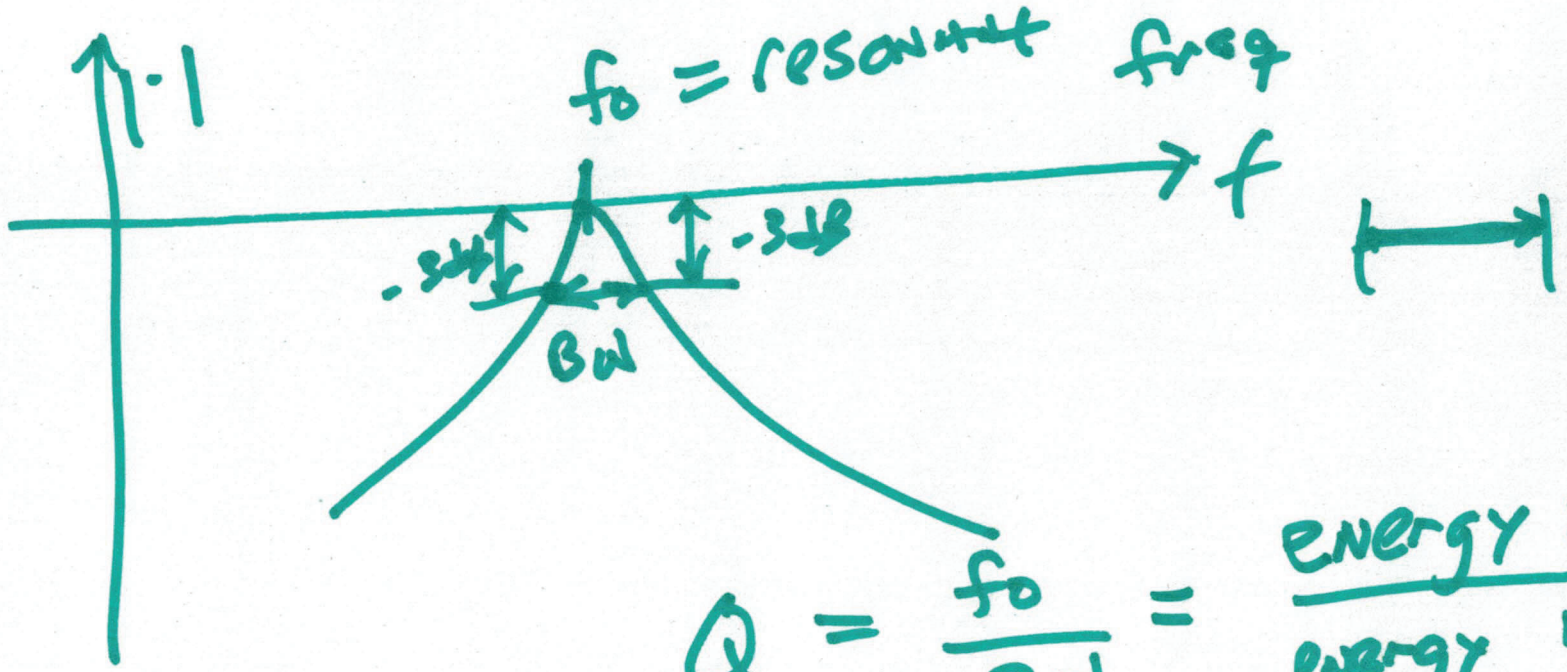
$$(2\pi f)^2 = \frac{10^3}{10^{-5}} = 10^{8\,4}$$

$$f = \frac{1}{2\pi \cdot 10^{-4}} = \frac{1}{2\pi\sqrt{LC}}$$

$$\sqrt{10^{-2} \cdot 10^{-6}} = \sqrt{10^{-8}}$$

$$= 10^{-4}$$

8)



$$Q = \frac{f_o}{BW} = \frac{\text{energy stored}}{\text{energy lost}}$$