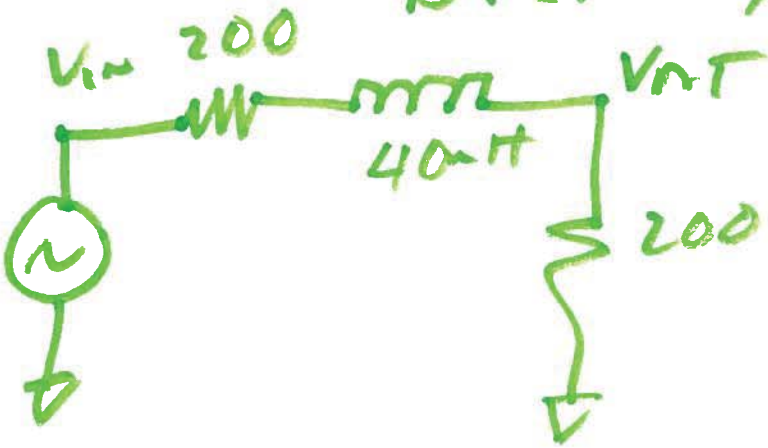
EE 220 Circuits 1

Lecture 27

Dec. 6, 2017

$s = \sigma + j\omega$

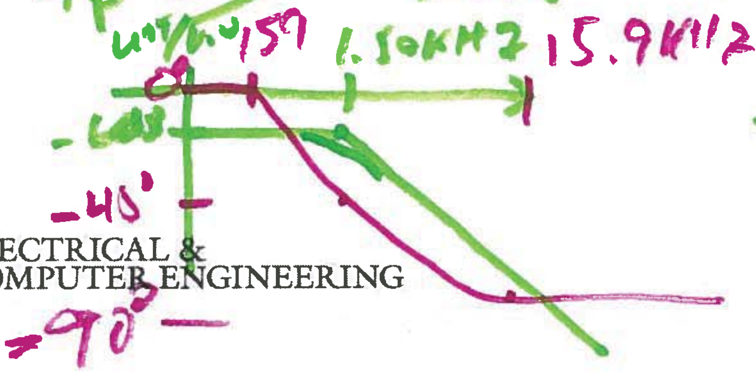


$$V_{OUT} = V_{IN} \cdot \frac{200}{200 + 200 + j\omega(.04)}$$

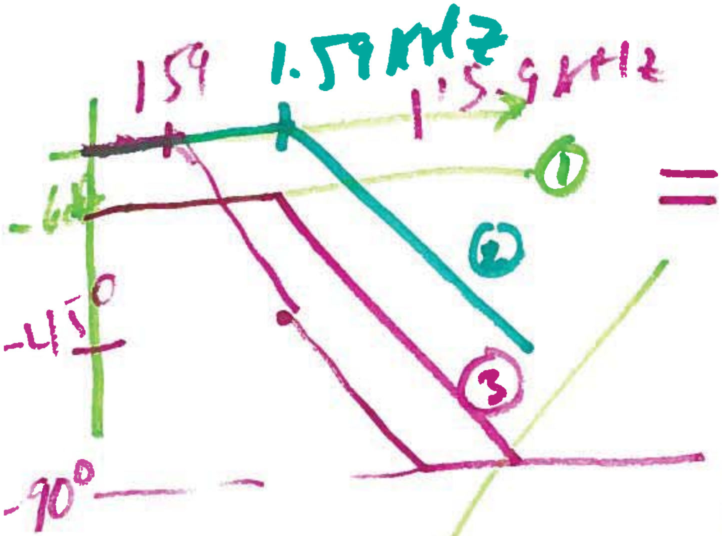
$$\frac{V_{OUT}}{V_{IN}} = \frac{200}{400 + j \cdot 2\pi \cdot (0.04) \cdot f}$$

$$f_p \Rightarrow 2\pi(0.04) \cdot f_p = 400$$

$$f_p = 1.59\,\text{kHz}$$



$$\frac{V_{OUT}}{V_{IN}} = \frac{200}{400 + j2\pi(0.04)\cdot f}$$



$$= \frac{200}{400}\cdot\frac{1}{1 + j\frac{2\pi(0.04)}{400}\cdot f}$$

$$f_p = \frac{1}{2\pi\cdot\frac{(0.04)}{400}} = 1.59kHz$$

$$\angle\frac{V_{OUT}}{V_{IN}} = -\tan^{-1}\frac{\frac{f}{1.59kHz}}{1}$$

$$2\pi\cdot\frac{(0.04)}{400} = \frac{1}{f_p}$$

1 3

$$\frac{V_{OUT}}{V_{IN}} = \frac{1}{2}\cdot\frac{1}{1+j\frac{f}{f_p}} = \left(\frac{1}{2}\right)\cdot\frac{1}{1+j\frac{f}{1.59kHz}}$$

2

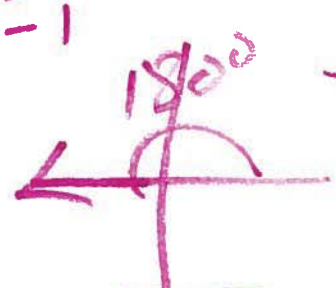
$$\left|\frac{V_{OUT}}{V_{IN}}\right| = \frac{\sqrt{\left(\frac{1}{2}\right)^2+0^2}}{\sqrt{1^2+\left(f/1.59k\right)^2}}$$

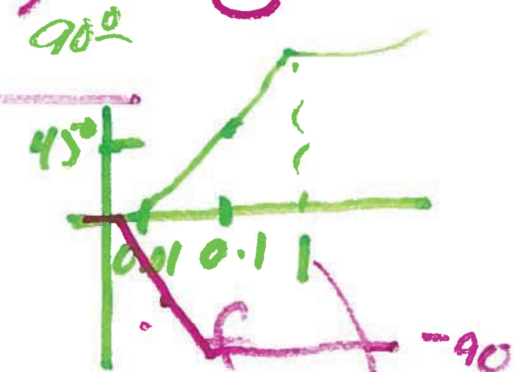
$$\frac{V_{OUT}}{V_{IN}} = -\cdot\frac{100 + j\cdot 1000\cdot f}{200 + j\cdot 10{,}000\cdot f}$$

$$= \frac{100\cdot(-1+j0)(1+j10f)}{200\left(1+j\cdot 50 f\right)} \qquad (180^{\circ}$$

$$\tan^{-1}\frac{0}{1/2} \rightarrow 0$$

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





$$= \frac{\left(\frac{1}{2}+j\cdot 0\right)(-1+j0)\left(1+j\frac{f}{0.1}\right)}{\left(1+j\frac{f}{0.02}\right)}$$

$$\angle\frac{V_{OUT}}{V_{IN}} = \underbrace{\tan^{-1}\frac{0}{1/2} + \tan^{-1}\frac{0}{-1}}_{180^{\circ}} + \tan^{-1}\frac{f/0.1}{1} - \tan^{-1}\frac{f/0.02}{1}$$

$$\left|\frac{V_{OUT}}{V_{in}}\right| = \frac{\sqrt{\left(\frac{1}{2}\right)^2+0^2}^{\,1/2}\cdot\sqrt{(-1)^2+(0)^2}^{\,1}\cdot\sqrt{1+\left(\frac{f}{0.1}\right)^2}}{\sqrt{1+\left(\frac{f}{0.02}\right)^2}}$$

→ Final Exam ←

Bode plots

Phasor Analysis

Integrators ←

Rms

First-order circuits → time domain

RC, CR

Thevenin/Norton LR, RL

$\tau = RC$

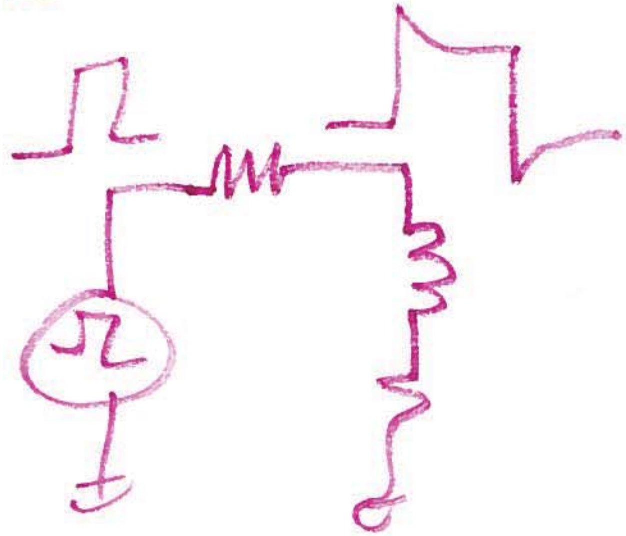
$= L/R$

Dependent sources

power mesh Analysis

superposition

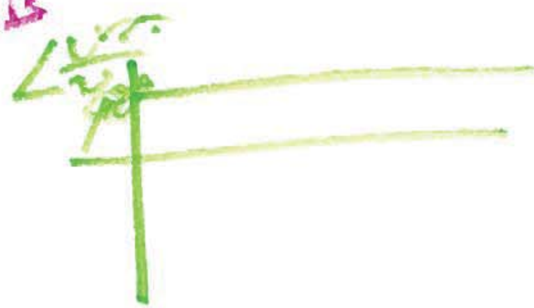
op-amp, Ohm's law KVL, KCL



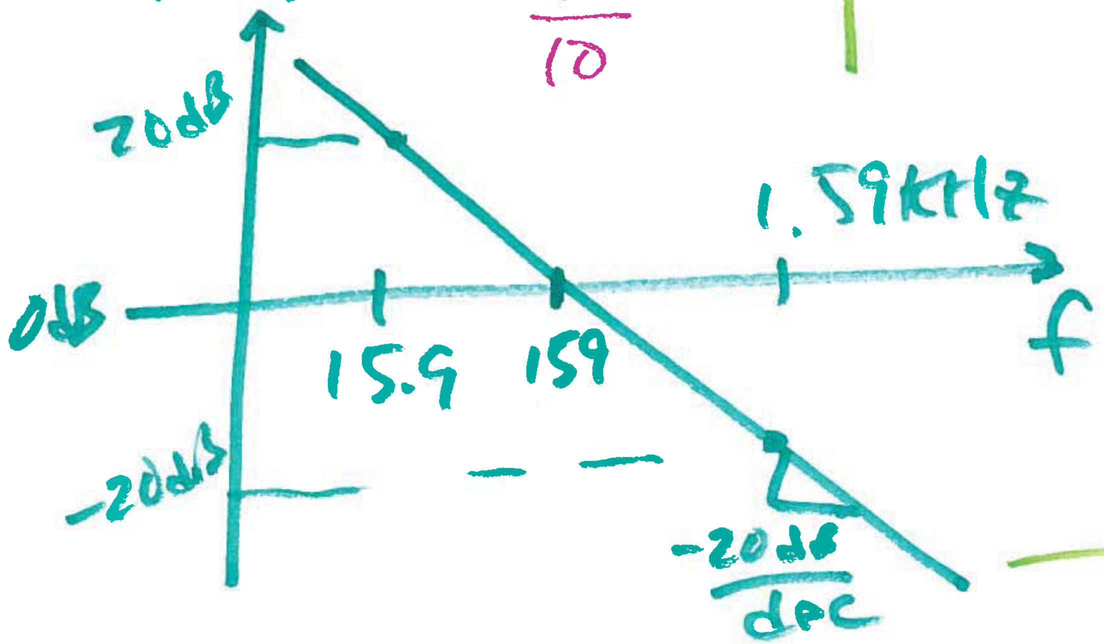
$\frac{1}{2\pi\cdot10^{-3}\cdot159} = 1$ (0dB)

$\frac{1}{2\pi\cdot10^{-3}\cdot15.9} = 10$ (20dB

$\left|\frac{v_{OUT}}{v_{IN}}\right| = \frac{1}{2\pi\cdot10^{-3}\cdot f}$, $\angle\frac{v_{OUT}}{v_{IN}} = 180° - \tan^{-1}\frac{2\pi\cdot10^{-3}f}{0}$ 90°



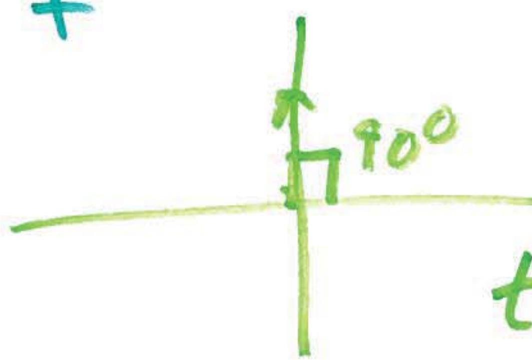
$= +90°$



$\frac{1}{10}$

$-\frac{1}{j\cdot2\pi\cdot10^{-3}f}\cdot\frac{j}{j}$

$= \frac{j}{2\pi\cdot10^{-3}f}$



$\tan^{-1}\frac{\frac{1}{2\pi\cdot10^{-3}f}}{0}$ +90°

$\frac{1}{2\pi\cdot10^{-3}f} = 1 \to f = \frac{1}{2\pi\cdot10^{-3}}$

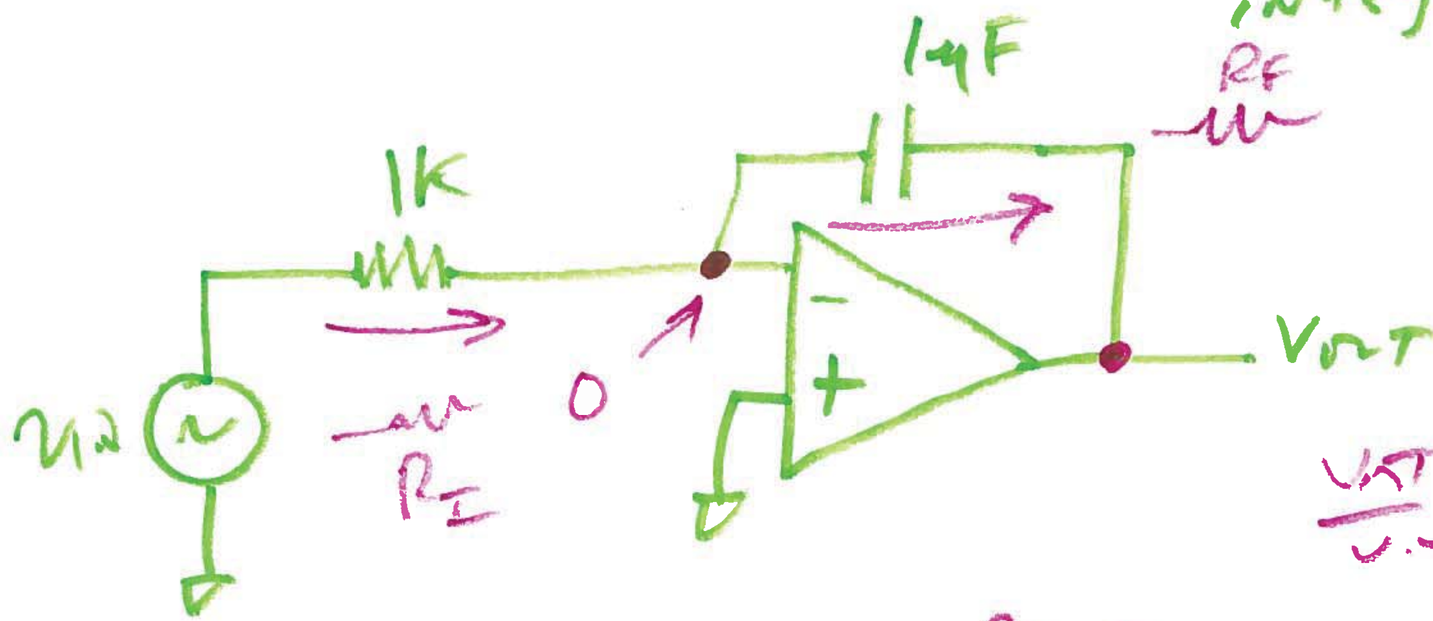
$\frac{159}{10} = 15.9$

10

$= 159\ Hz$

b)

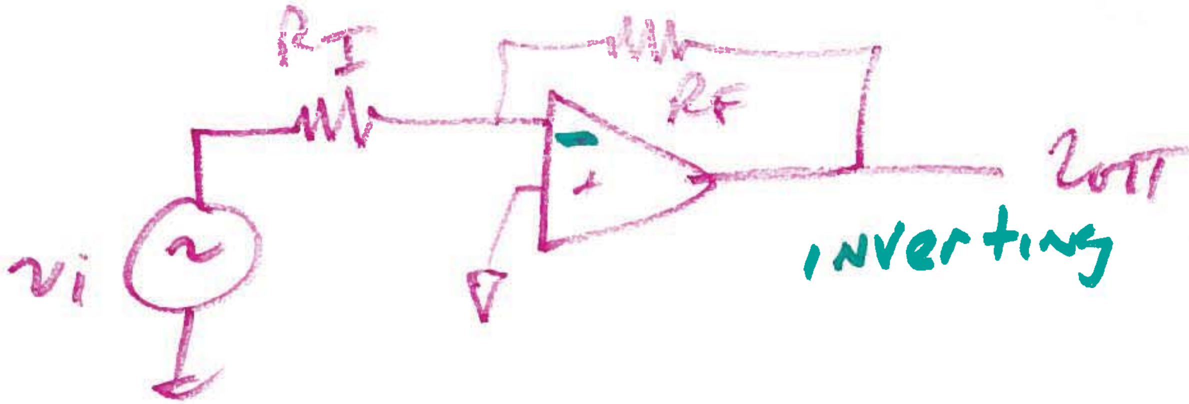
Frequency Response of An integrator



$$\frac{V_{OUT}}{V_{in}} = \frac{-R_F}{R_I}$$

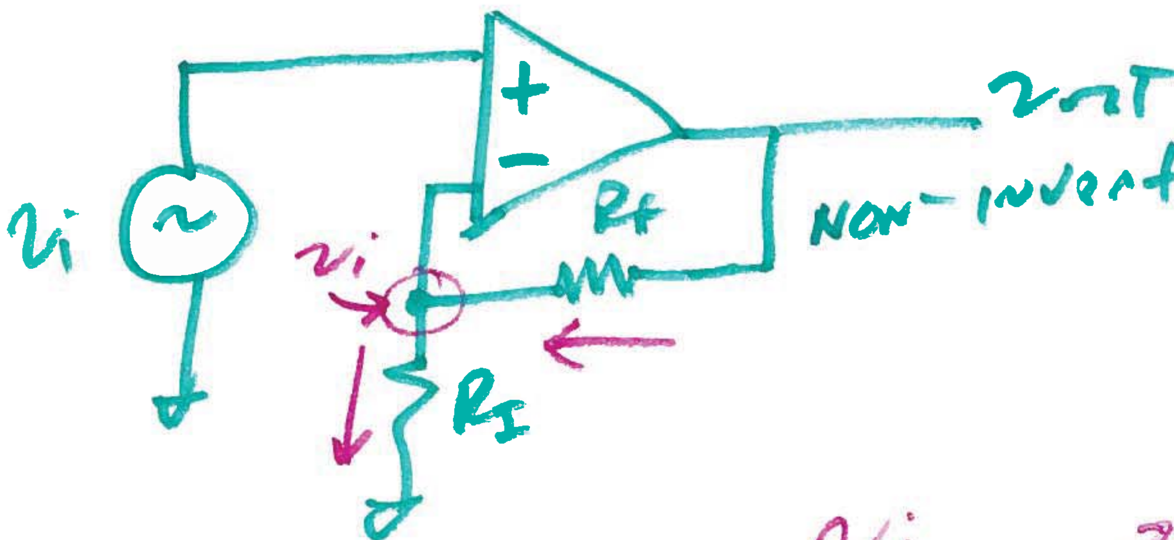
$$\frac{v_{in}}{1K} = \frac{0 - v_{OUT}}{1/j\omega \cdot 1\mu F}$$

$$\frac{v_{OUT}}{v_{in}} = -\frac{1/j\omega 1\mu F}{1K} = -\frac{1}{j \cdot 2\pi \cdot 10^{-3} \cdot f}$$



inverting

$$\frac{v_{OUT}}{v_{IN}} = -\frac{R_F}{R_I}$$



non-inverting

$$\frac{v_{OUT}}{v_{IN}} = \frac{R_I + R_F}{R_I}$$

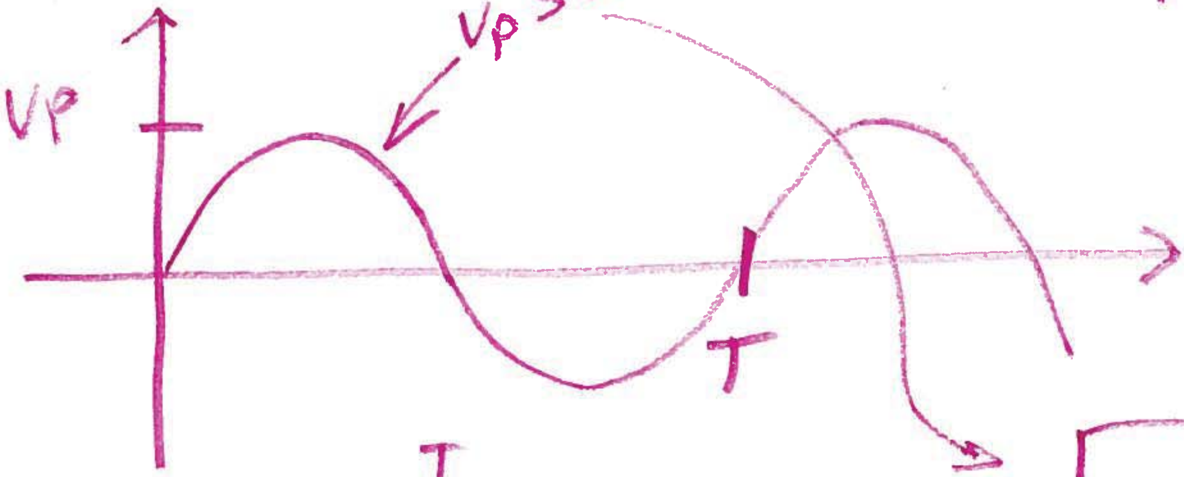
$$= 1 + \frac{R_F}{R_I}$$

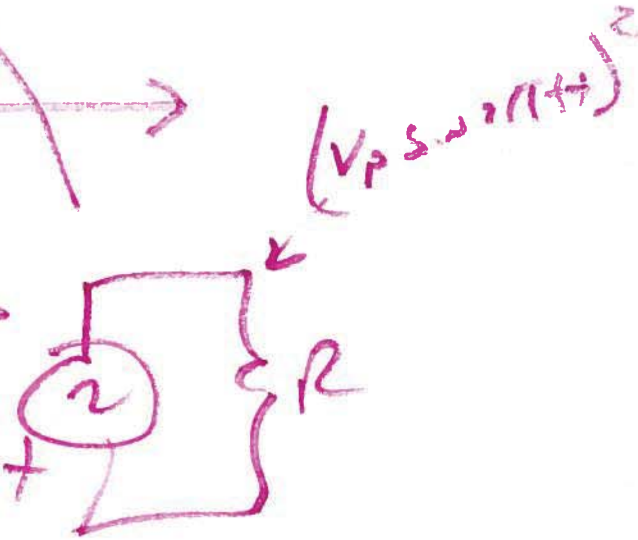
$$\frac{v_{OUT} - v_i}{R_F} = \frac{v_i}{R_I}$$

Q)

RMS

$$P = \frac{V_{rms}^2}{R} = I_{rms}^2 \cdot R$$





$$V_{rms}^2 = \frac{1}{T}\int_0^T V_p^2 \sin^2 2\pi f \cdot t \; dt$$

$$\sin^2 x = \frac{1}{2}(1 - \cos 2x)$$

$$= \left(\frac{V_p^2}{T2}\right)\int_0^T \left(1 - \cos 2(2\pi f \cdot t)\right) \cdot dt$$

$$u = 2 \cdot 2\pi f \cdot t$$

$$du = 2\pi f \cdot dt$$

$$dt = \frac{du}{4\pi f}$$

$$= \frac{V_p^2}{T2}\int_0^T dT - \frac{1}{4\pi f}\int_0^T \cancel{\cos u \cdot du} \rightarrow 0$$

$$V_{rms}^2 = \frac{V_p}{2\cancel{T}}\cdot(\cancel{T} - 0)$$

$$V_{rms}^2 = \frac{V_p^2}{2}$$

$$V_{rms} = \frac{V_p}{\sqrt{2}}$$