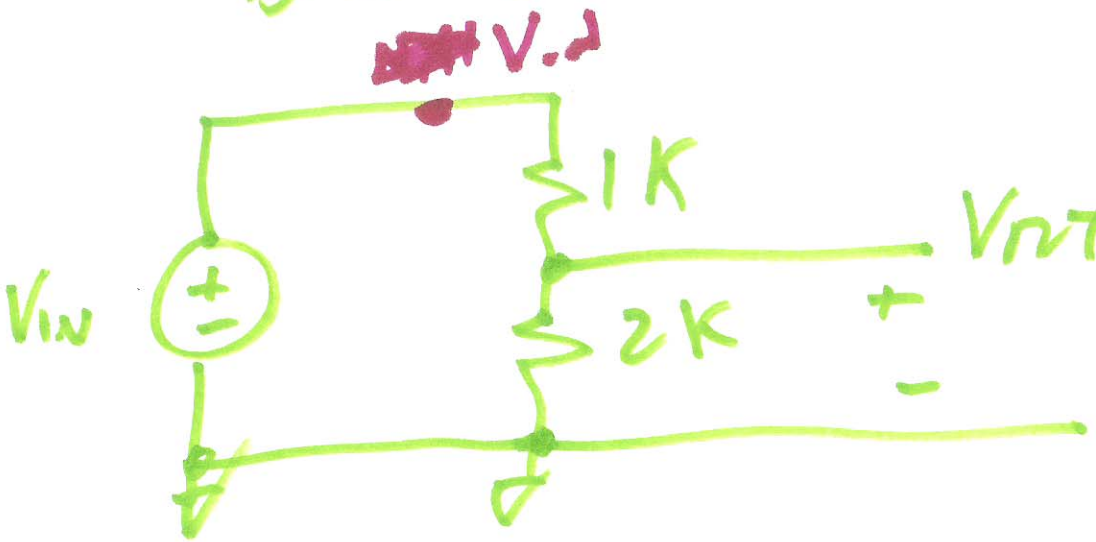
Lecture 2

JAN. 23, 2015

EE 320

$V_{OUT} = \frac{2}{3} V_{IN}$

DC sweep



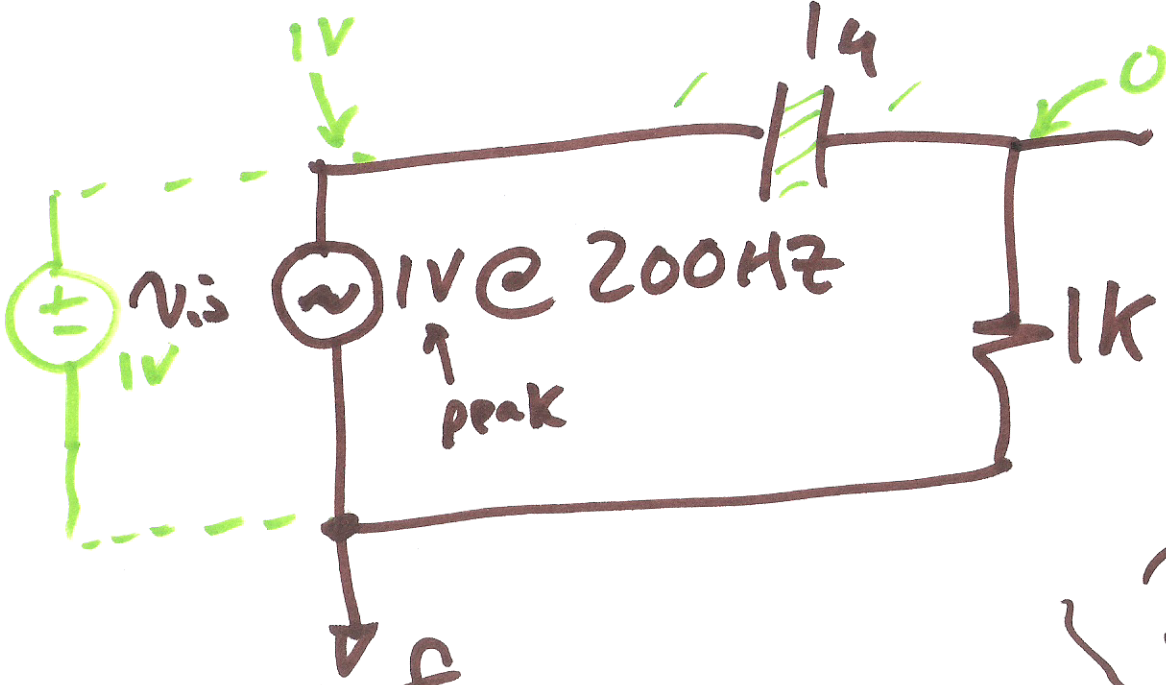
$-2 \rightarrow 5$

$\frac{2}{3}$

$V_{OUT} = V_{IN} \cdot \frac{2K}{1K + 2K}$

My netlist

```
Vin Vin 0 dc 0
R1  Vin Vout 1K
R2  Vout 0 2K
.dc Vin -2 5 m
```



$$v_{out} = v_{in} \cdot \frac{1K}{1K + \frac{1}{j\omega C}}$$

v_{in}: $1\angle 0$, $1 + j0$

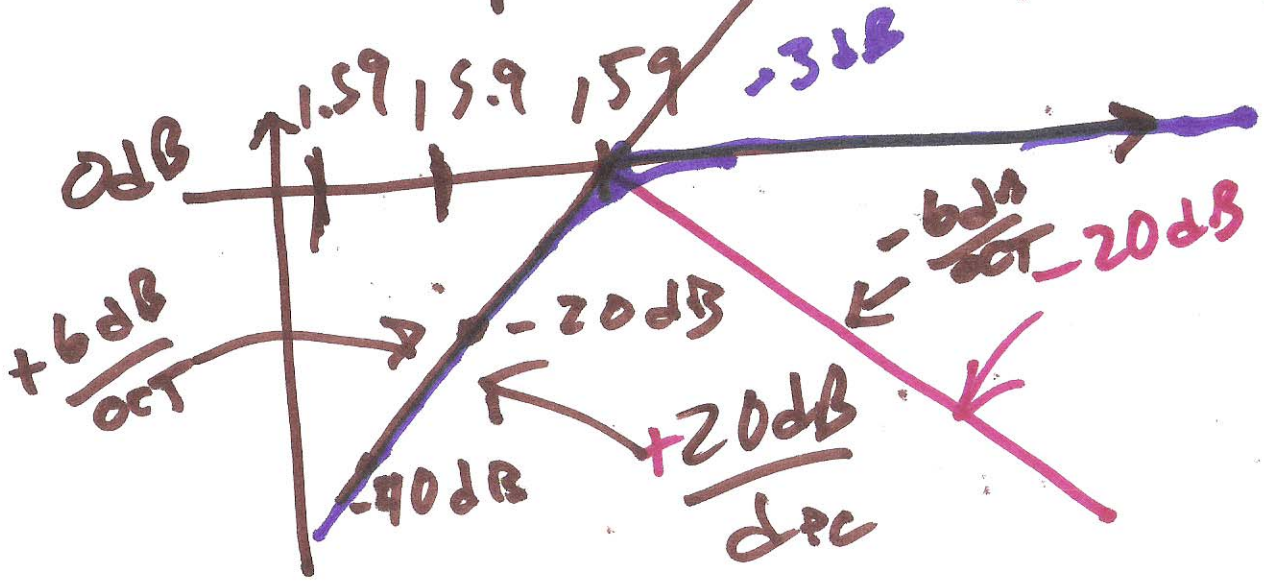
$$\frac{v_{out}}{v_{in}} = \frac{10^3 \cdot j \cdot 2\pi f \cdot 10^{-6}}{10^3 \cdot j \cdot 2\pi f \cdot 10^{-6} + 1}$$

$$\frac{0 + j\frac{f}{f_z}}{1 + j\frac{f}{f_p}} \qquad \frac{v_{out}}{v_{in}} = \frac{0 + j6.28 \cdot 10^{-3} \cdot f}{1 + j6.28 \cdot 10^{-3} \cdot f}$$

$$\frac{0 + j\frac{f}{159}}{1 + j\frac{f}{159}} = \frac{0 + j \cdot 0.00628\, f}{1 + j0.00628 \cdot f}$$

$$\frac{V_{out}}{V_{in}} = \frac{0 + j\frac{f}{159}}{1 + j\frac{f}{159}}$$

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



-20dB ⇒ $\frac{1}{10}$
-14dB ⇒ $\frac{1}{5}$
-6dB ⇒ $\frac{1}{2}$

0dB = $\frac{V_{out}}{V_{in}} = 1$

+6dB ⇒ 2
+14dB ⇒ 5
20dB ⇒ 10
+3dB → $\sqrt{2}$
-3dB → $\frac{1}{\sqrt{2}}$

Oct. ×2
×2

2K → 4K

$$20\log\left|\frac{V_{out}}{V_{in}}\right| = 20\log\frac{\sqrt{1^2+\left(\frac{f}{15.9}\right)^2}}{\sqrt{1^2+\left(\frac{f}{159}\right)^2}}$$

$$\log\frac{a}{b} = \log a - \log b$$

$$20\log\frac{f}{159} - 20\log\sqrt{1+\left(\frac{f}{159}\right)^2}$$

15.9

$20\log\frac{f}{159}$

$f = 159$

0

$f = 15.9$

$f = 1.59$

$-40\,dB$

1 decade $\times 10$ $\div 10$

$20\log\frac{1}{10} = 20\log 10^{-1}$

$= -20$

$20\log 10^{-2} = 20\log\frac{1}{100}$

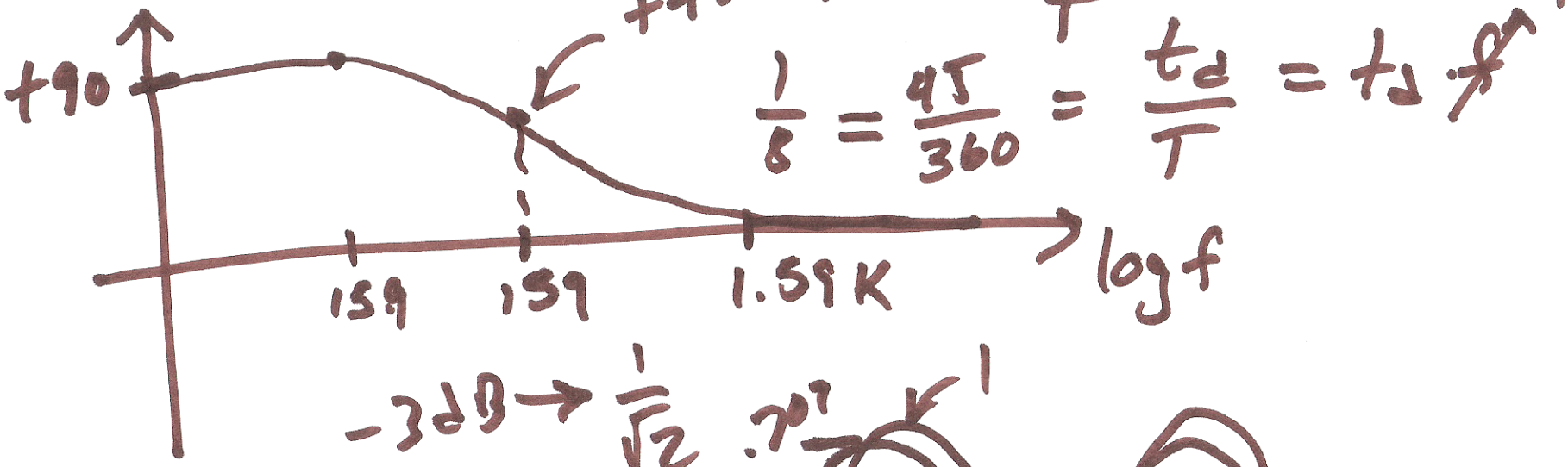
$$\frac{v_{nT}}{v_{in}} = \frac{0 + j\frac{f}{159}}{1 + j\frac{f}{159}}$$

$$\angle \frac{v_{nT}}{v_{in}} = \tan^{-1}\frac{\frac{f}{159}}{0} - \tan^{-1}\frac{f}{159}$$

$+90^\circ$

$+45^\circ \rightarrow \theta = \frac{t_d}{T} \cdot 360$

$\frac{1}{8} = \frac{45}{360} = \frac{t_d}{T} = t_d \cdot f \cdot 159$



$-3dB \rightarrow \frac{1}{\sqrt{2}}$

$-6dB \rightarrow \frac{1}{2}$

$-14dB \rightarrow \frac{1}{5}$

5)

$$\left.\frac{V_{out}}{V_{in}}\right|_{@200} = \frac{0 + j\frac{200}{159}}{1 + j\frac{200}{159}}$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{\frac{200}{159}}{\sqrt{1 + \left(\frac{200}{159}\right)^2}} = \frac{1.25}{1.61} = .78$$

$$\angle\frac{V_{out}}{V_{in}} = \tan^{-1}\infty - \tan^{-1}\frac{200}{159}$$

90

51.45

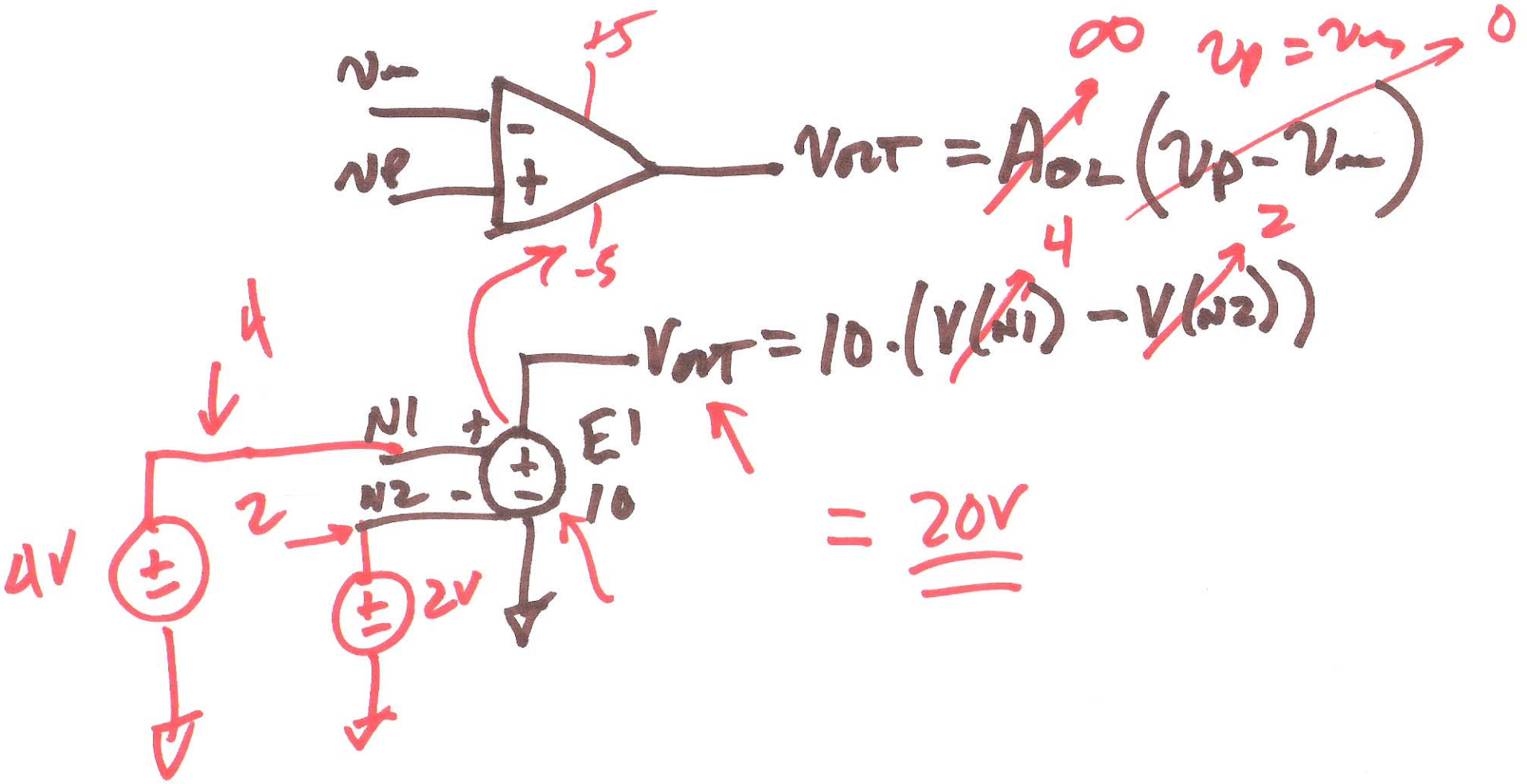
$$\angle\frac{V_{out}}{V_{in}} = 38.5^\circ$$

$$t_d = \frac{38.5^\circ}{360 \cdot 200}$$

$$\theta = \frac{t_d}{T} \cdot 360 = t_d \cdot 360 \cdot 200$$

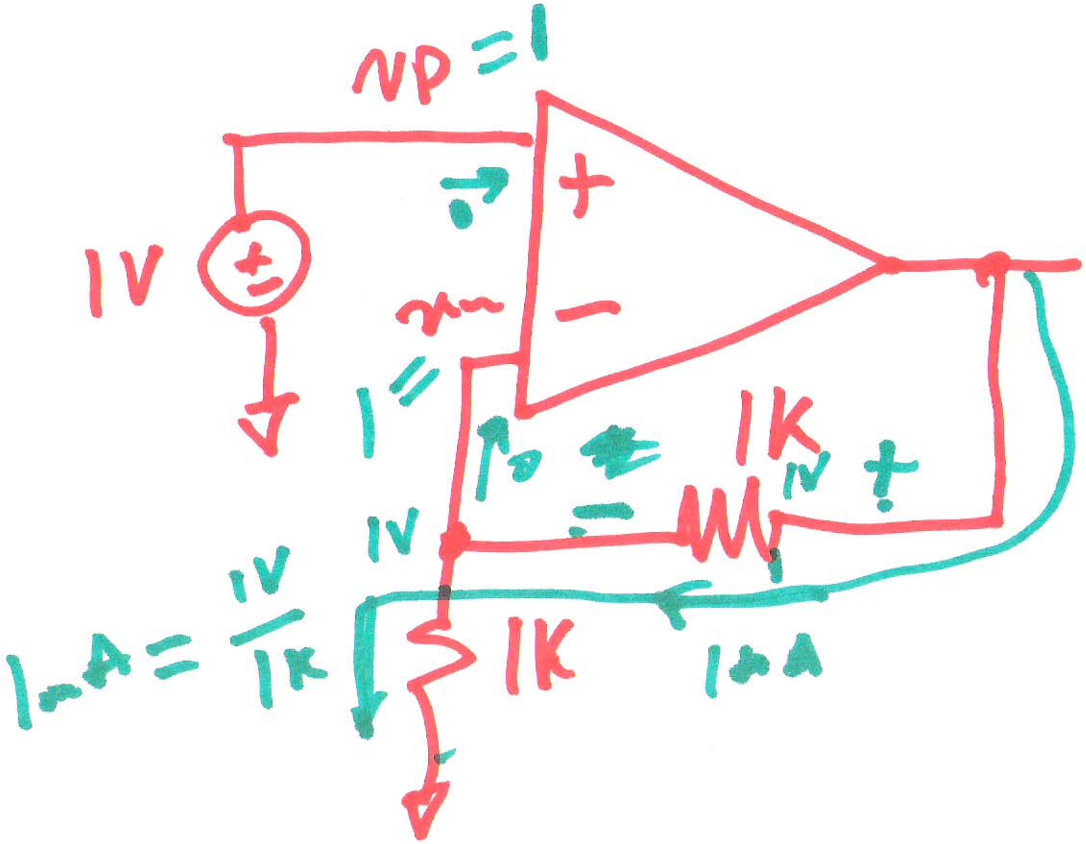
$$= .534\,ms$$

b)


Vm
Vp
+5
-5
VOUT = AOL (Vp - Vm)
∞
Vp = Vm
0
VOUT = 10 · (V(N1) - V(N2))
4
2
4V
2
2V
N1
N2
E1
10
= 20V

Ideal op-amp

$A_{OL} = \infty$



$v_{OUT} \Rightarrow \infty(v_p - v_m)$

$\Downarrow$

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