

ECE3204 Lecture 5

Noninverting Gain (2.3)

Inverting Gain (2.2)

Bandwidth Limit (2.7)

Handouts:

Transfer function review

1st Order System Step Response /
Bandwidth Risetime Relationship

Op-Amp as a Classical Feedback
System

Bode plot Guide / s-Plane Review

"Language" of Transfer Function

π 3.14159...



CURVES IN ROAD

"Muito obrigado" Thank you very much

$$H(j\omega) = \frac{1}{1+j\omega\tau} \quad \$\$$$



Transfer function

ω FREQUENCY CHANGES

EVALUATE $H(j\omega)$ 2 THINGS IN ONE NUMBER!

$|H(\omega)|$ SCALES SINUSOID AMPLITUDE

$\angle H(\omega)$ DELAY INPUT TO OUTPUT
TIME AS PHASE ANGLE

Op-Amp Analysis

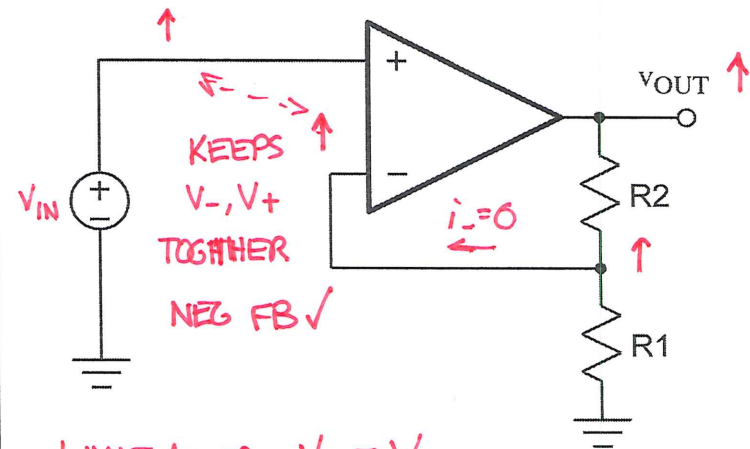
FIRST: CHECK NEGATIVE FEEDBACK

1. Change v_{IN}
2. Follow change around loop
3. Does v_{OUT} change to keep v_- , v_+ together?
If yes: negative feedback

THEN $v_- \approx v_+$

(How \approx ? Depends on A large)

Simpler analysis of noninverting gain op-amp circuit



$$\text{LIMIT } A \rightarrow \infty \quad v_- = v_+$$

VOLTAGE DIVIDER: ($i_- = 0$)

$$v_- = \left(\frac{R_1}{R_1 + R_2} \right) v_{OUT}$$

||

$$v_+ = v_{IN}$$

$$v_{OUT} = \underbrace{\left(\frac{R_1 + R_2}{R_1} \right)}_{\text{NONINVERTING GAIN}} v_{IN}$$

Inverting Gain Op-Amp Circuit

NEG FEEDBACK?

$V_{IN} \uparrow$ ①

$V_- \uparrow$ ②

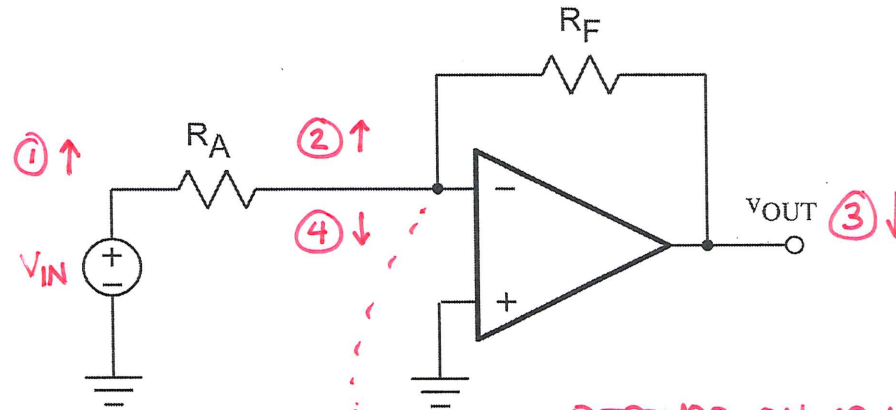
OPAMP RULE

$V_{OUT} = A(V_+ - V_-)$



$V_{OUT} \downarrow$ ③

$V_- \downarrow$ ④ BACK TOWARDS GROUND
 $V_+ = 0$



DEPENDS ON OP-AMP A
 "VIRTUAL GROUND"
 MAINTAINED NEAR ZERO BY NEGATIVE FEEDBACK

$\frac{V_{OUT}}{A} \} 100,000 \approx 10s \text{ of } \mu V$