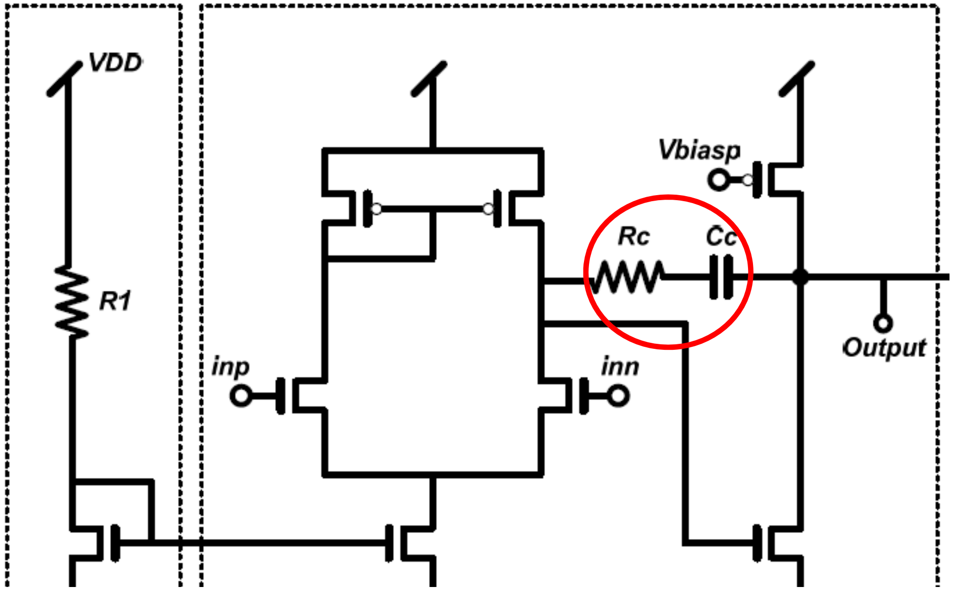
Lect. 30: Design Project #2



-Design Goals

Parameter	Value
A_V [10]	> 70dB (Differential)
BW (3-dB Bandwidth) [10]	> 80kHz
Phase Margin [10]	> 60°
$V_{p\text{-}p}$ [10]	> 2V
Slew Rate [10]	> 90MV/s
Power Consumption [10]	< 2.5mW

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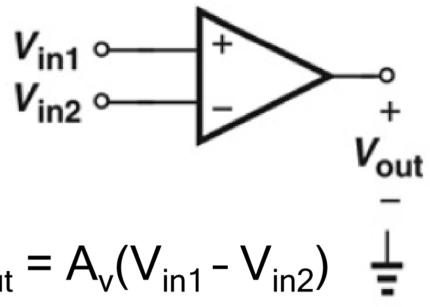
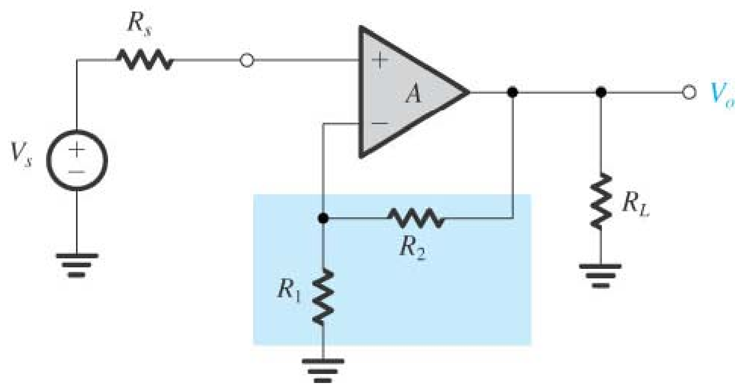
Application of the differential amplifier?



$V_{out} = A_v(V_{in1} - V_{in2})$

Op-amp is most often used with feedback (Lect. 4)



$$\frac{V_o}{V_s} = \frac{R_1 + R_2}{R_1}$$

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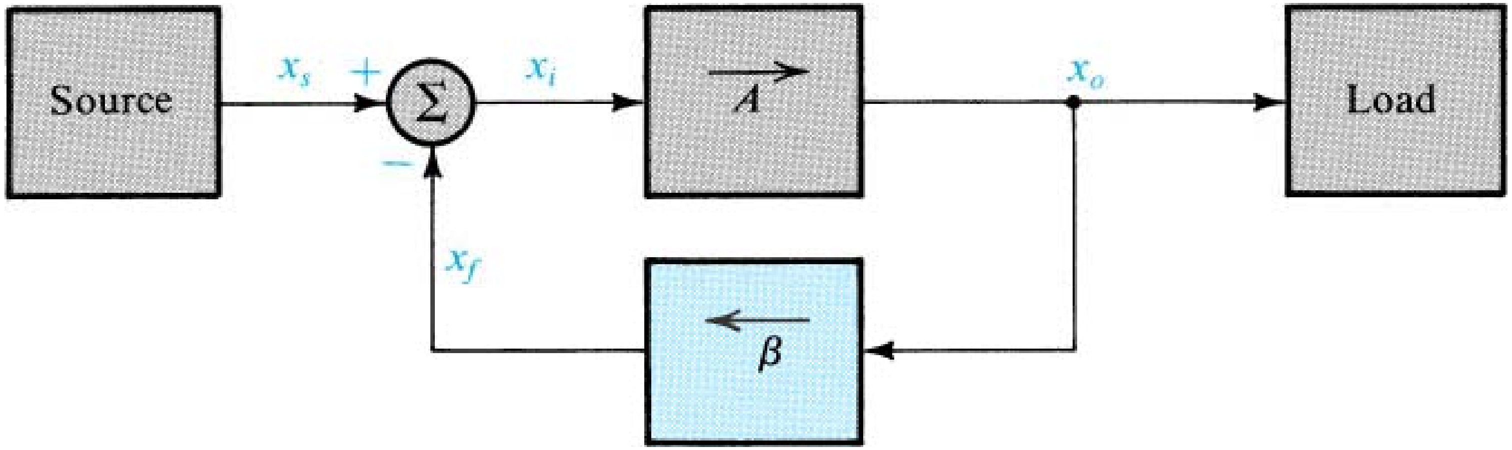

$$x_o = Ax_s$$

$$x_f = \beta x_o$$

$$x_i = x_s - x_f \quad = x_s - \beta x_o$$

$$x_o = Ax_i = A(x_s - \beta x_o)$$

$$x_o(1 + A\beta) = Ax_s$$

$$\therefore A_f = \frac{x_o}{x_s} = \frac{A}{1 + A\beta}$$ (Close loop gain)

($A\beta$: loop gain)

If A is frequency dependent: $A_f = \dfrac{A(s)}{1 + \beta A(s)}$

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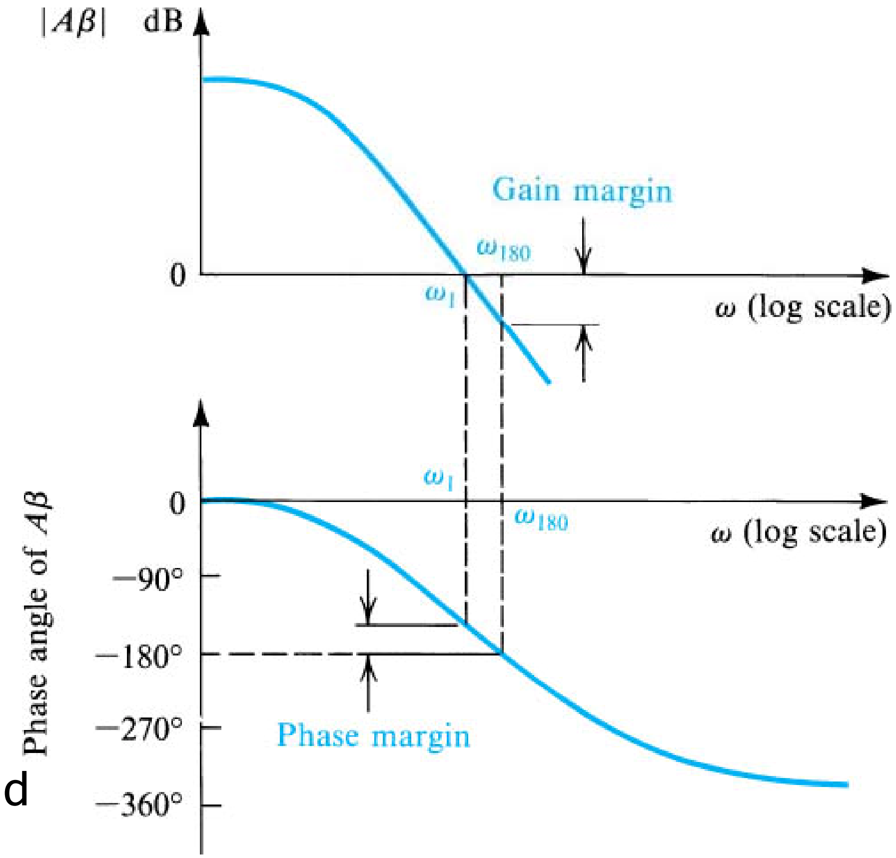
Is feedback always possible? ➔ Stability of feedback system

$$A_f(s) = \frac{A(s)}{1+\beta A(s)}$$

If $\beta A(s)$ = -1, system becomes unstable !

For stable feedback system design,

Phase [$\beta A(s)$] > -180 deg when |$\beta A(s)$| = 1



Design $A(s)$ with feedback application in mind
➔ Provide sufficient phase margin

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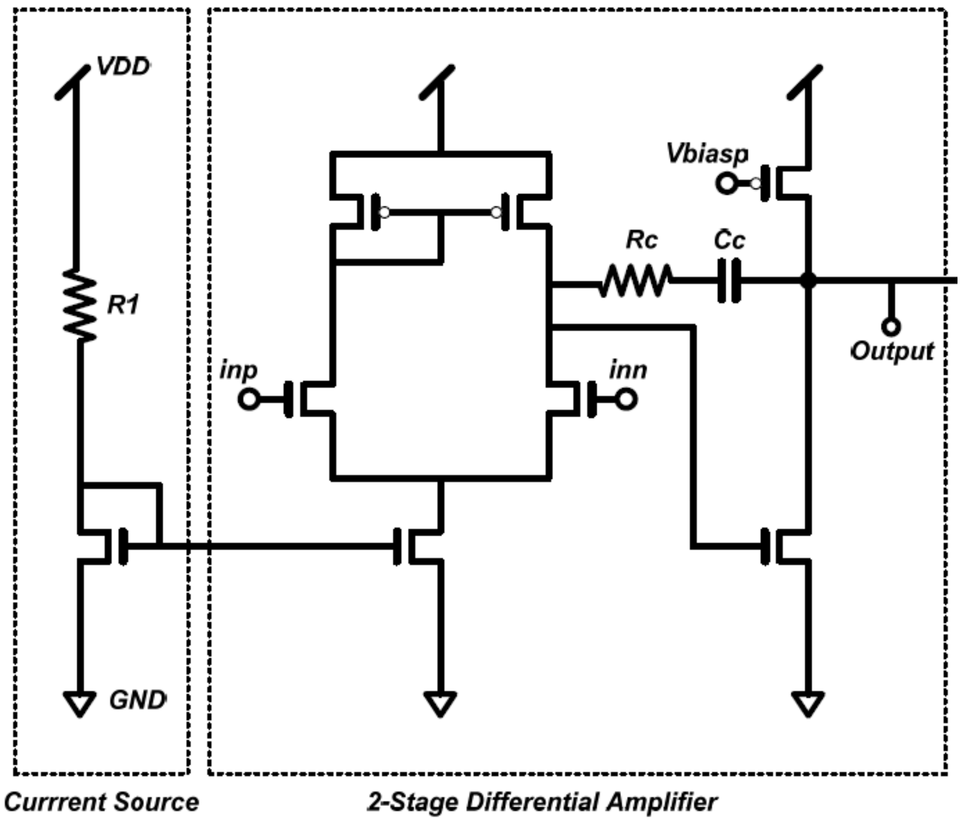

It turns out satisfying phase margin in 2-stage amp is very challenging

Adding RC in parallel can provide much enhancement in phase margin!

➔ Frequency compensation (Details will be explained in Electronic Circuits II)

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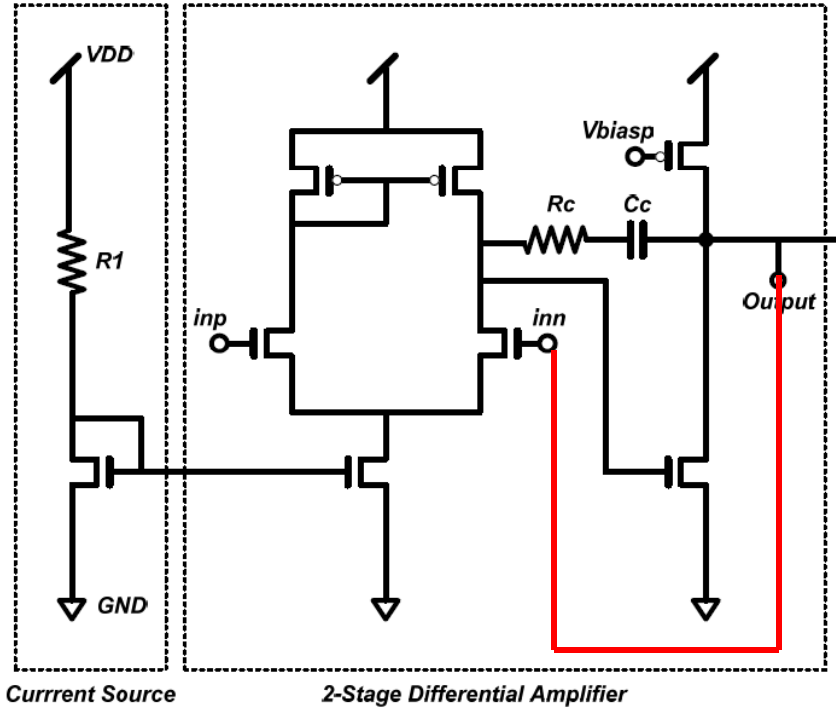
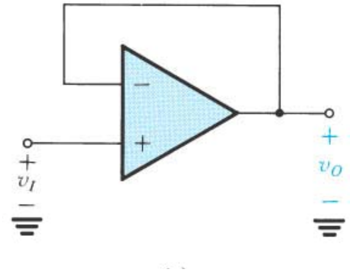
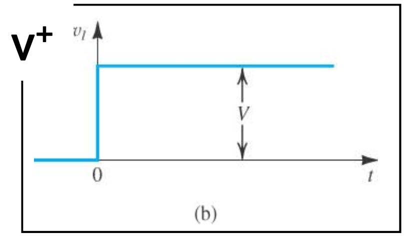
Slew Rate



What does the circuit do?



Apply step input at v^+



How fast can $v_o(t)$ catch up with input?

➔ Slew rate

➔ I through R_c and C_C

Use simulation to optimize frequency compensation and slew rate