## Schedule for Remainder of Semester

11/22 – Q12 + Direct calculation of loop gain

11/25 – Oscillators (12.13, 12.14)

11/27 – Nonlinear op amp circuits (12.12) (Hmwk 14 due)

12/2 – Waveform generators (12.13)

12/4 – Quiz #13 + Demo (?)

12/6 – Review (Hmwk 15 due)

12/13 – Final Exam 2:50–5:40pm

---

## Direct calculation of Loop Gain

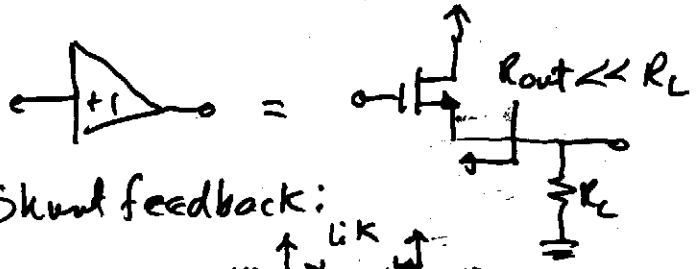
Why calculate the loop gain? $R_{inF} = \frac{R_{in}}{1+LG}$

1.) Can estimate the influence of negative feedback on input and output resistance.

Shunt: $R_{inF} = \frac{R_{in}}{1+\underbrace{AB}_{LG}}$ and $R_{outF} = \frac{R_{out}}{1+\underbrace{AB}_{LG}}$

Series: $R_{inF} = R_{in}(1+\text{Loop Gain})$ & $R_{outF} = R_{out}(1+\text{Loop Gain})$

### Example – Buffer

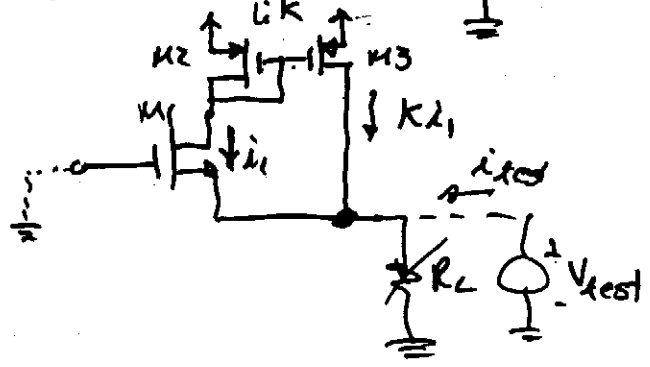



$R_{out} \approx \frac{1}{g_m}$

$g_m = \sqrt{2K'\frac{W}{L}I}$

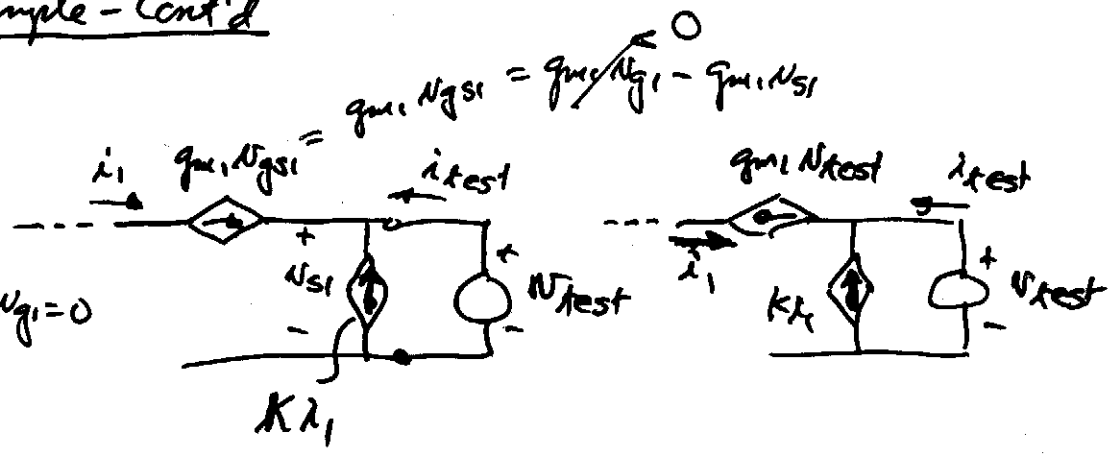
$100\,\mu A/V^2$

Shunt feedback:




$R_{outF} = \frac{V_{test}}{i_{test}}$

Example - Cont'd




$$i_{test} = g_{m1}V_{test} - Ki_1 = g_{m1}V_{test} - K(-g_{m1}V_{test})$$

$$i_{test} = V_{test}(g_{m1} + g_{m1}K)$$

$$\therefore R_{OUTF} = \frac{V_{test}}{i_{test}} = \frac{1}{g_{m1}(1+K)}$$

2.) Stability analysis.

Methods for calculating Loop Gain

1.) Direct
2.) Successive voltage and current

→ Example