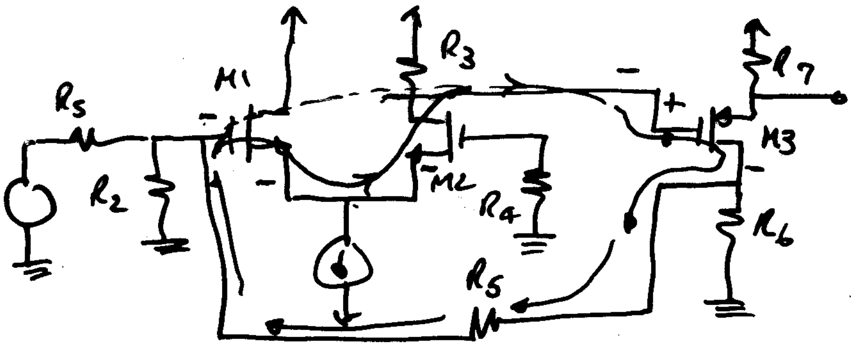
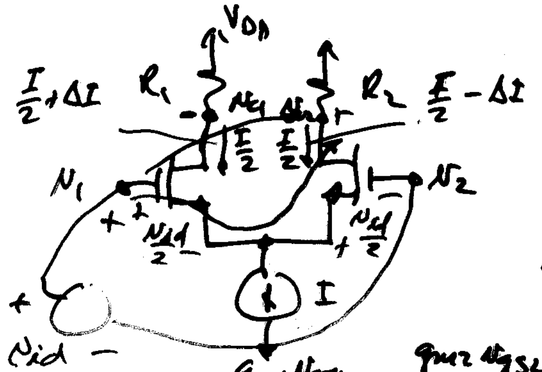
Final Exam Problem Session

Lecture 4/5/04 – Shunt-series fb. example



How is the feedback loop completed thru the diff. amp?



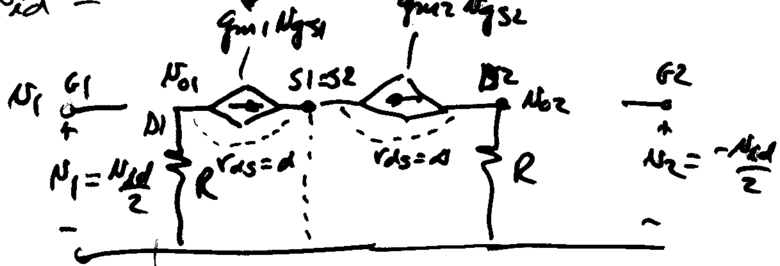
$R_1 = R_2 = R$

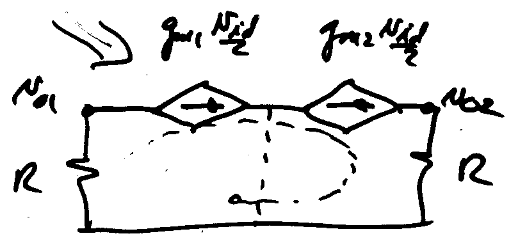
$$v_{o1} = V_{DD} - \left(\frac{I}{2} + \Delta I\right) R$$

$$v_{o2} = V_{DD} - \left(\frac{I}{2} - \Delta I\right) R$$

$$v_{o2} - v_{o1} = \cancel{V_{DD}} - \cancel{\frac{I}{2}R} + \Delta I \cdot R - \cancel{V_{DD}} + \cancel{\frac{I}{2}R} + \Delta I R$$

$$= 2 \Delta I R$$





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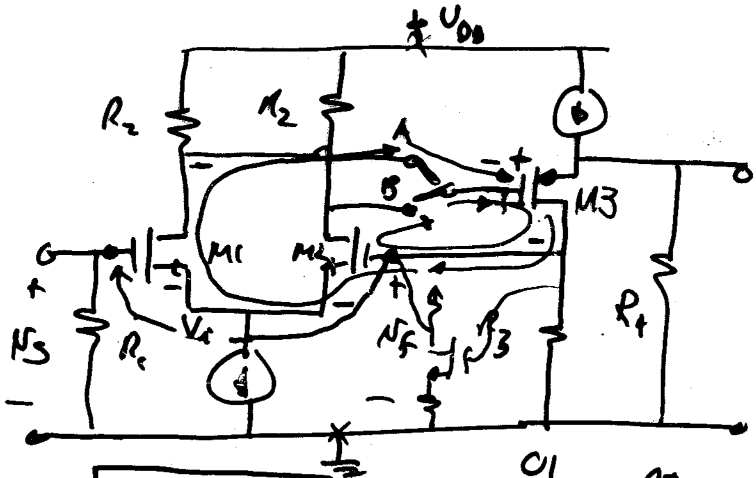
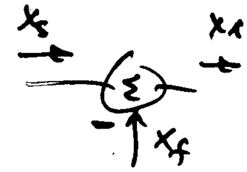


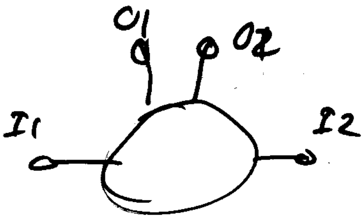


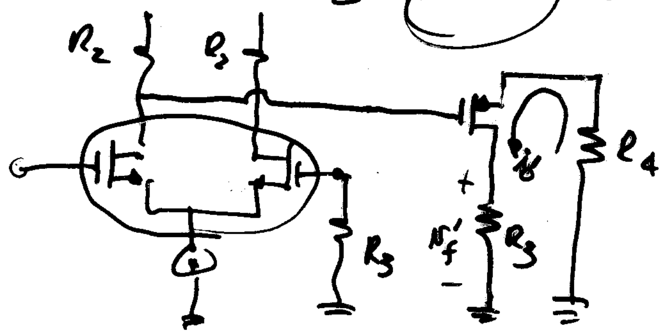
$u_i = u_s - u_f$

$u = v$ or i

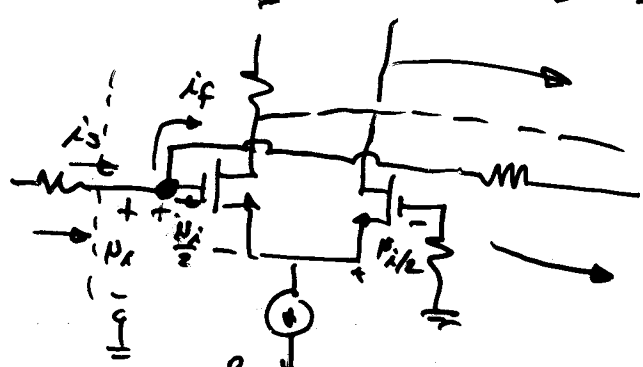
$\boxed{v_i = v_s - v_f}$

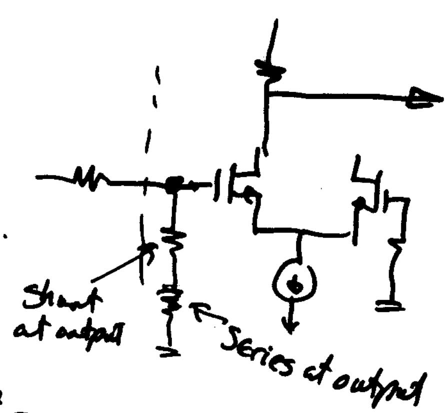
$i_i = i_s - i_f$

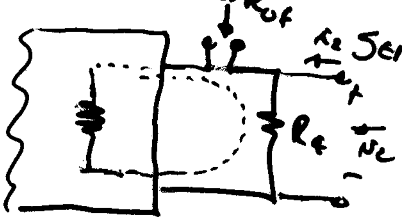




$F = \frac{v_f'}{i_o'} = R_3$





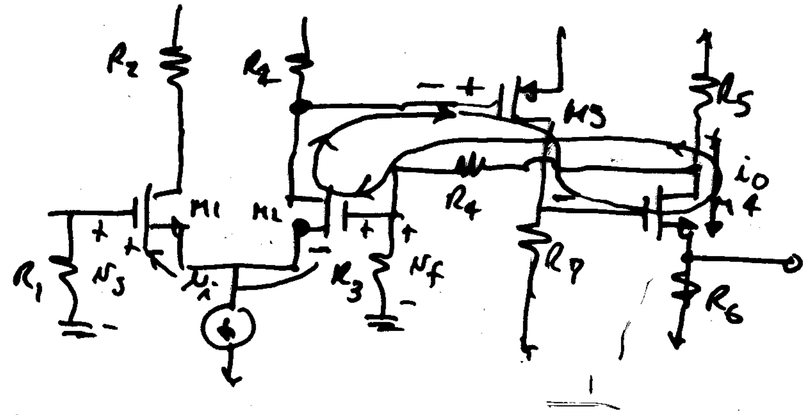


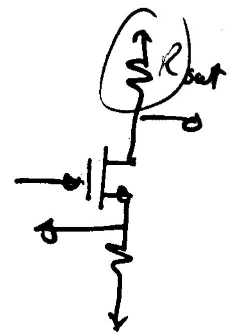
Series at output –

R_o ("output" resistance – loop open)

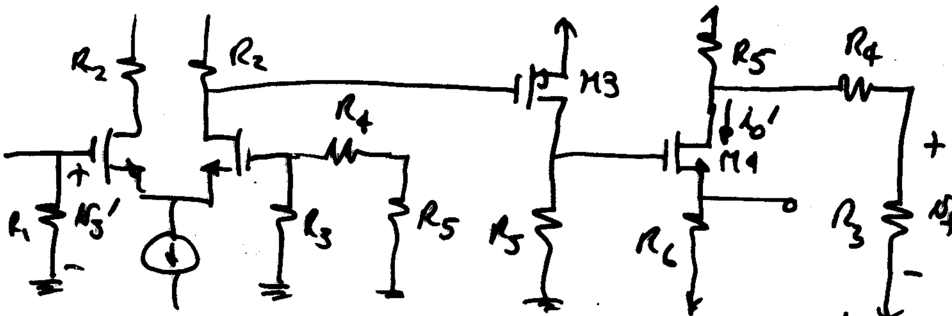
$R_{OF} = R_o(1+AF)$

$\frac{v_2}{i_2} = R_4 \| (R_{OF} - R_4)$





Open-loop schematic - $(1+g_{m4}R_6)$



$$F = \frac{v_f'}{v_o'} = \frac{v_f'}{i_o'} = \frac{-R_5 R_3}{R_3+R_4+R_5}$$

$$A = \frac{i_o'}{v_s'}$$

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Q. On (b.)

$$T(j\omega) = \frac{-(g_m R)^3}{[1 - 3\omega^2 R^2 C^2] + j\omega RC[3 - \omega^2 R^2 C^2]} = 1 + j0$$

$$3 - \omega^2 R^2 C^2 = 0 \rightarrow \omega^2 = \frac{3}{R^2C^2} \rightarrow \omega_{osc} = \frac{\sqrt{3}}{RC}$$

Ok for $\omega = \omega_{osc}$ what is T?

$$\frac{-(g_m R)^3}{[1 + 3\omega_{osc}^2 R^2 C^2]} = \frac{-(g_m R)^3}{1 + 3R^2C^2 \times \frac{3}{R^2C^2}} = \frac{-(g_m R)^3}{1-9} = 1$$

$$(g_m R)^3 = 8$$

$$\underline{\underline{g_m R = 2}}$$

Suppose switch is connected to A.

$$T(s) = \frac{(g_m R)^3}{D(s)}$$

$$T(j\omega) = \frac{+(g_m R)^3}{\underbrace{[1 - 3\omega^2 R^2 C^2]}_{1-9=-8} + j\omega RC\underbrace{[3 - \omega^2 R^2 C^2]}_{=0}} = 1 + j0$$