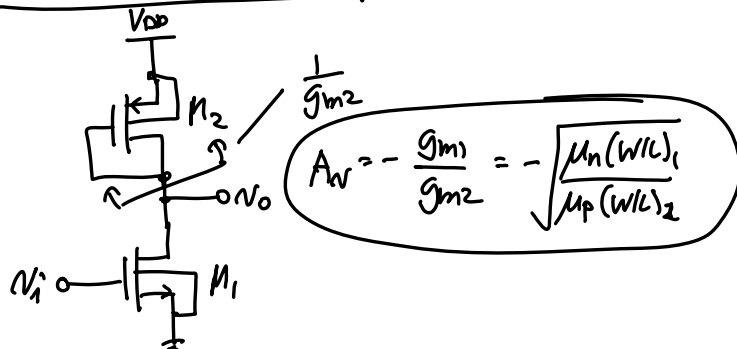


Today:

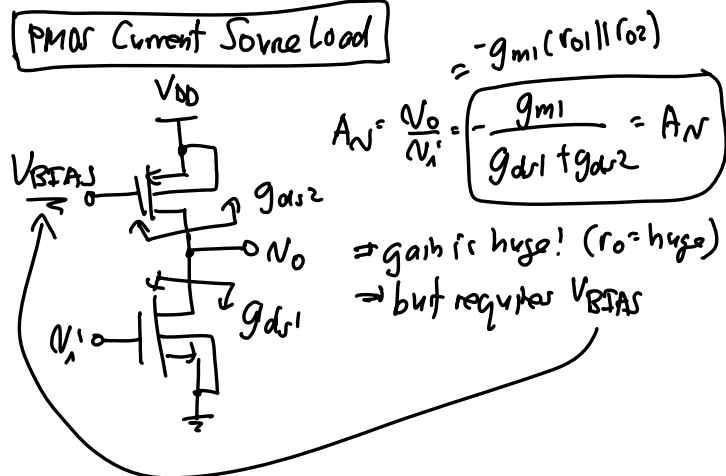
- Active Load Examples
- Current Source V_{BIAS} Generators
- Problem 4 moves to HW#4

Last Time -

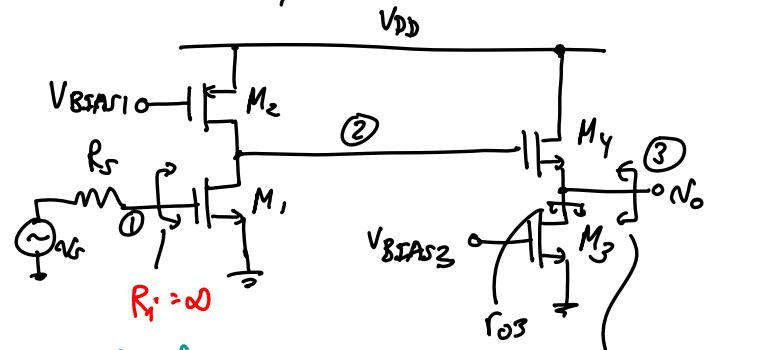
Diode-Connected PMOS Load



PMOS Current Source Load



Ex. Multistage Actively-Loaded MOS Ckt.

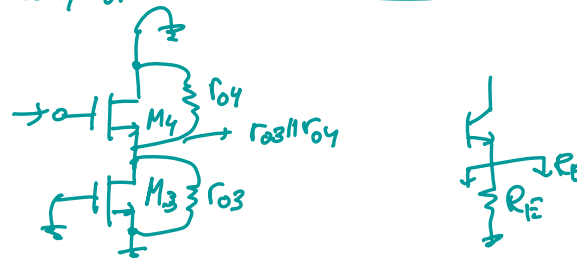


$$R_o = \frac{1}{g_{m4} + g_{m3}} || r_{o3}$$

$$R_o \approx \frac{1}{g_{m4}}$$

$$A_v = -g_{m1}(r_{o1} || r_{o2}) \left[\frac{g_{m4}}{g_{m4} + g_{m3}} \right]$$

Why r_{o4} ?

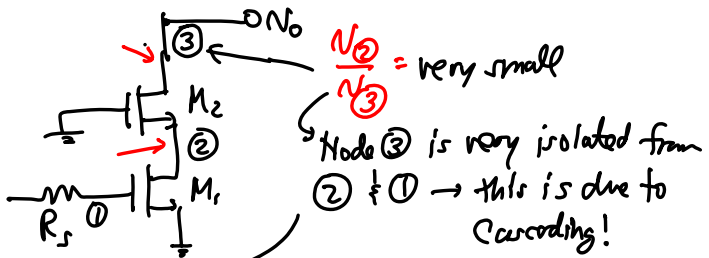


H.F. Analysis -

$\tau_1 = [C_{gs1} + C_{gs1}(1 + g_{m1}(r_{o1} || r_{o2}))] R_S$
 $\tau_2 = (C_{gs1} + C_{db1} + C_{gd2} + C_{gd4} + C_{db2})(r_{o1} || r_{o2})$
 $\tau_3 = (C_{db3} + C_{gs3} + C_{sb4}) \left[\frac{1}{g_{m4} + g_{mb4}} \right]$
 $\tau_{gs4} = C_{gs4} \left[\frac{(r_{o1} || r_{o2}) + (r_{o3} || r_{o4})}{1 + (g_{m1} + g_{mb4})(r_{o3} || r_{o4})} \right] \rightarrow \text{small}$
 $\omega_H = \frac{1}{\tau_1 + \tau_2 + \tau_3 + \tau_{gs4}}$

Ex. Cascode Drive & Load

$R_0 = r_{o3}(1 + g_{m3} + g_{mb3})r_{o4} || r_{o2}(1 + (g_{m2} + g_{mb2})r_{o1})$
 $A_N = \frac{V_{O1}}{V_S} \cdot \frac{V_{O2}}{V_{O1}} \cdot \frac{V_O}{V_{O2}} \propto 1$
 $= (1) \left(-g_{m1} \left(\frac{1}{g_{m2} + g_{mb2}} \right) (g_{m2} + g_{mb2}) R_0 \right) = -g_{m1} R_0 = A_N$
Get dominant pole: (use OCTC analysis)
 $\tau_1 = (2C_{gs1} + C_{gs1}) R_S$
 $\tau_2 = (2C_{gs1} + C_{gs2} + C_{db1} + C_{sb2}) \left(\frac{1}{g_{m2} + g_{mb2}} \right)$
 $\tau_3 = (C_{gd2} + C_{gs3} + C_{db2} + C_{db3}) R_0$
Use OCTC methods:
 $\omega_H = \frac{1}{\tau_1 + \tau_2 + \tau_3}$
 → this is accurate enough...
 ...but... can one be a bit smarter about this?



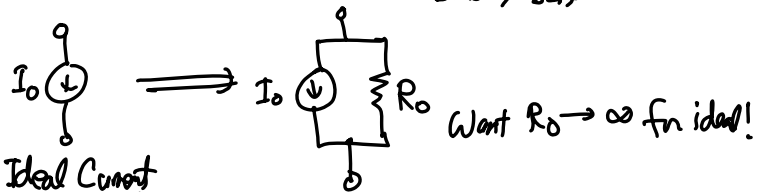
↳ Whenever you see a lot of isolation between nodes, then each node can be associated w/ a distinct pole

So:

S₀:
(i) Node ③ contributor the dominant pole: $\omega_p = \frac{1}{\tau_3}$

(ii) Capacitors associated w/ ① & ② contribute the 2nd pole: $\omega_{p2} = \frac{1}{\tau_1 + \tau_2}$

Transition Current Sources \rightarrow how do we get V_{BSAS1} , V_{BSAS2} , V_{BSAS3} ?



Ideal Current Source

Actual Current

