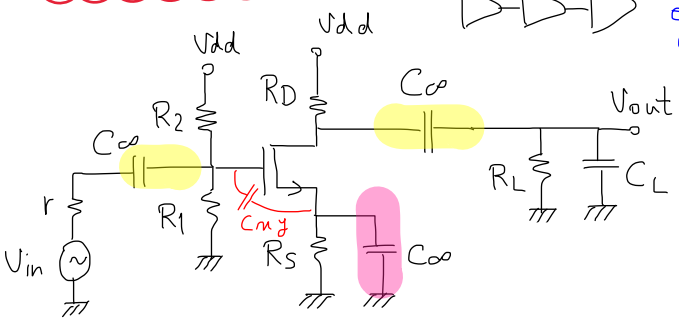
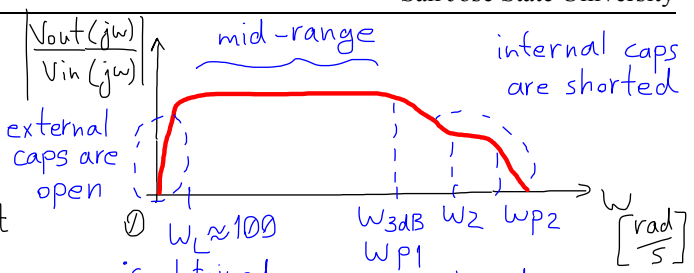
* Amplifier Design:





$W_L \approx 100$ is obtained by short circuit time constant method

W_{3dB} W_{p1} is obtained using open circuit time constant method

- C_{co} is in range 10pF
- C_L is in range 100fF
- C_{my} is in range 10fF

- @ $w \approx 0$, capacitors are open, $V_{out} \approx 0$
- @ L.F., external large capacitors get shorted
- @ M.F, external caps are short and internal caps are open and maximum gain is achieved

→ W_z; zero frequency is obtained using feedback null technique

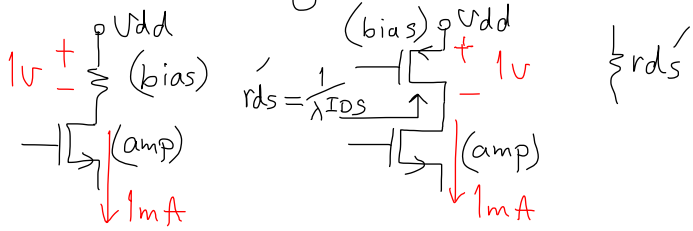
→ W_{p2}; is obtained using open conductance method (developed by Dr. Hamedi)

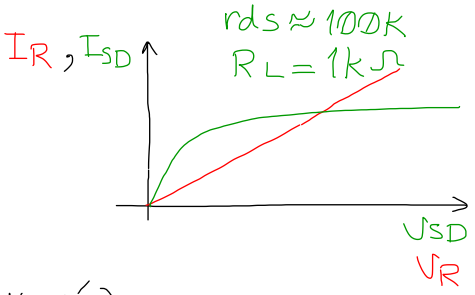
coupling C_{co} caps are used to isolate the biasing of different stages

bypass C_{co} caps are used to short a node @ high frequency

→ in IC design, coupling capacitors use a large area and must be eliminated.

→ in IC design, bias the drain of an amplifier using a transistor rather than using a resistor.



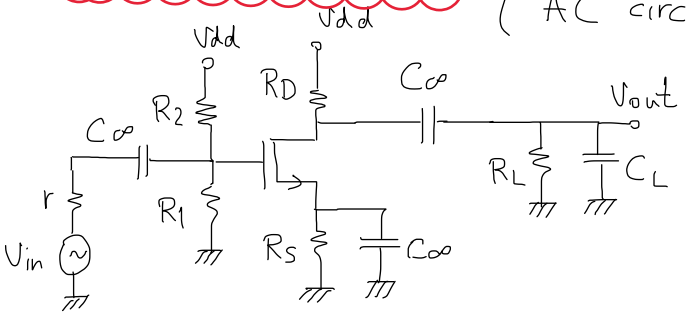


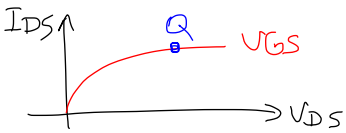
$|\text{voltage gain}| = g_m(r_{ds} \| R_L)$ $\quad 10\times10^{-3}(100k \| 1k) = 10$

$|\text{voltage gain}| = g_m(r_{ds} \| r_{ds}')$ $\quad 10\times10^{-3}(100k \| 100k) = 500$

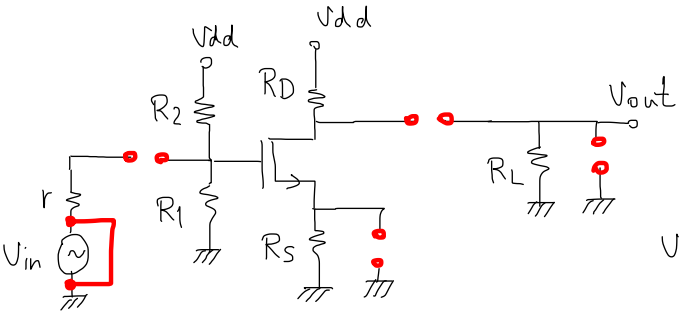
* Circuit Analysis :

{ DC circuit → DC analysis
  AC circuit → AC analysis } use superposition





* DC circuit



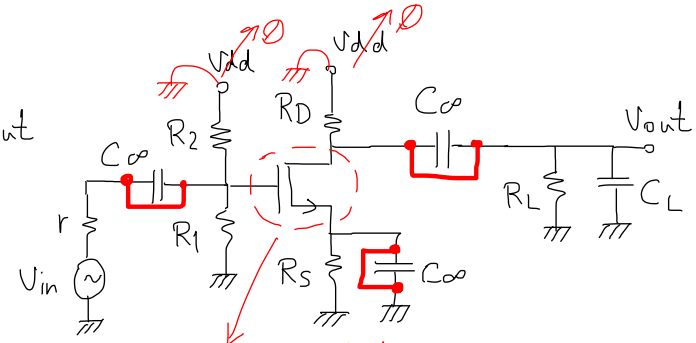
find I_{DS}, V_{GS}, V_{DS}

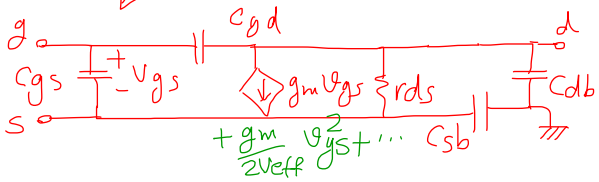
active { $V_{GS} \geq V_{th}$
$V_{DS} \geq V_{GS} - V_{th}$

$g_m = \mu_n C_{ox} \frac{W}{L}(V_{GS} - V_{th})$

$r_{ds} = \frac{1}{\lambda I_{DS}}$

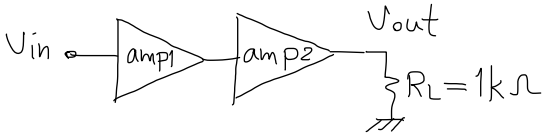
* AC circuit

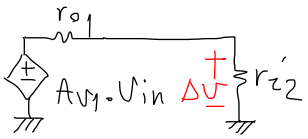


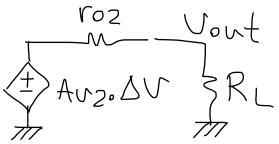


find A_{V0}, R_{in}, R_{out}, ω_{3dB}, ω_{P2}, ω_Z

(C.S, C.D, C.G, S.D, Cascode, diff-pair)





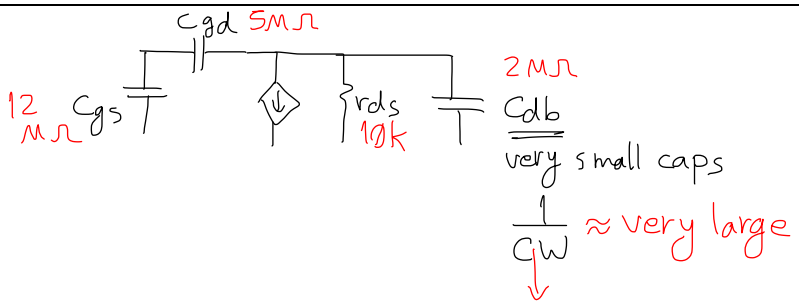


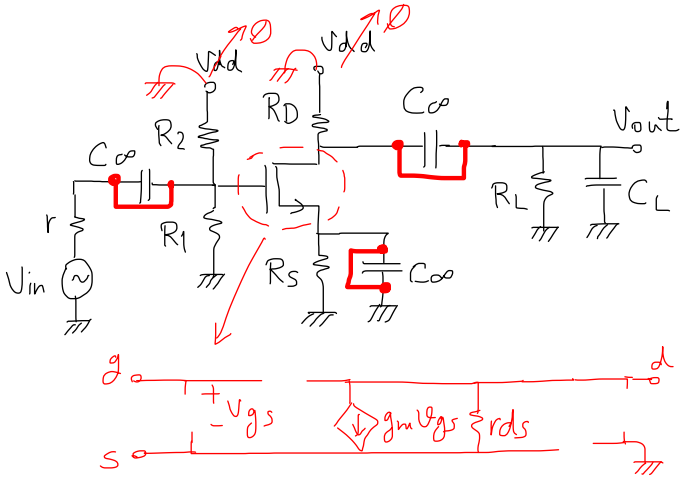
$r_{o1} = 9k\Omega$, $r_{i2} = 1k\Omega$, $r_{o2} = 9k\Omega$, $R_L = 1k\Omega$

$V_{out} = A_{V2} \cdot \Delta V \frac{R_L}{r_{o2} + R_L} = A_{V2} \frac{R_L}{r_{o2} + R_L} \times A_{V1} \cdot V_{in} \frac{r_{i2}}{r_{o1} + r_{i2}}$

$\frac{V_{out}}{V_{in}} = A_{V1} \cdot A_{V2} \cdot \frac{1}{10} \times \frac{1}{10}$

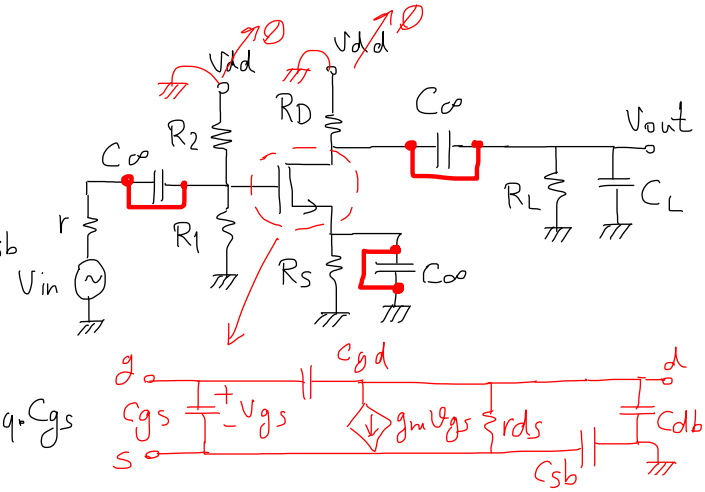
* Find $A_{V\infty}$:
  - → open all internal caps
  - → find $\frac{V_{out}}{V_{in}} = A_{V\infty}$





* find ω_{3dB} (or ω_{p1}):
  - → find time constant for each internal cap
  - → $\omega_{3dB} = \frac{1}{\tau_{gs} + \tau_{gd} + \tau_{db} + \tau_{sb}}$

keep C_{gs}, open other caps
find R_{eq} across C_{gs}, $\tau_{gs} = R_{eq} \cdot C_{gs}$
repeat for other caps



* find ω_z:
  - → find condition that make output zero ⟹ extract ω_z

* find ω_{p2}:
  - no method is developed

* find ω_L:

→ use short circuit time constant method

→ keep a cap and short all other caps find time constant repeat for other caps

→ $\omega_L = \frac{1}{\tau_1} + \frac{1}{\tau_2} + \cdots$