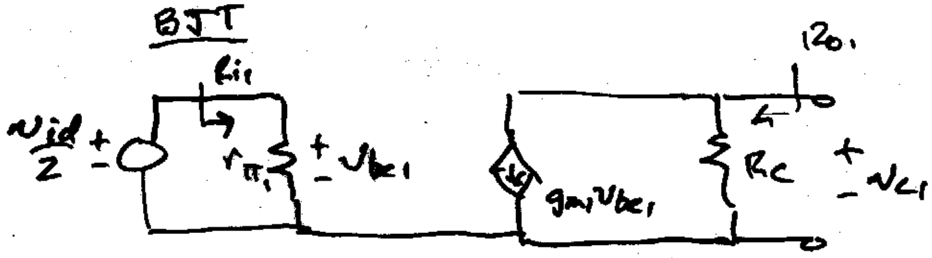
BJT

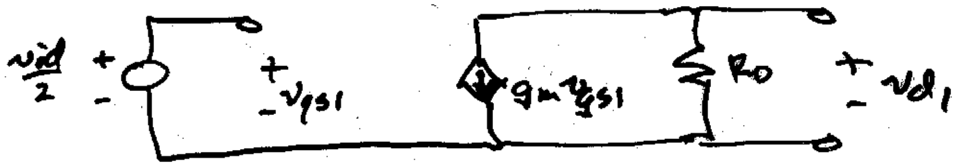


$A_{vd} = \frac{v_{c1}}{v_{id}} = -\frac{g_m R_C}{2} \Rightarrow \frac{v_{od}}{v_{id}} = -g_m R_C$

$R_{i1} = r_{\pi 1}$ $\quad R_{id} = \frac{v_{id}}{i_b} = \frac{v_{id}}{\frac{v_{id}/2}{r_\pi}} = 2 r_\pi$

$R_{od} = 2(R_C \| r_o)$ $\quad v_{c1} = -g_m R_C \frac{v_{id}}{2}$

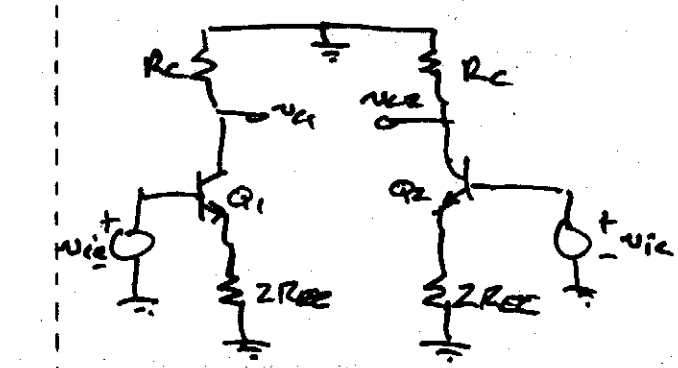
MOSFET

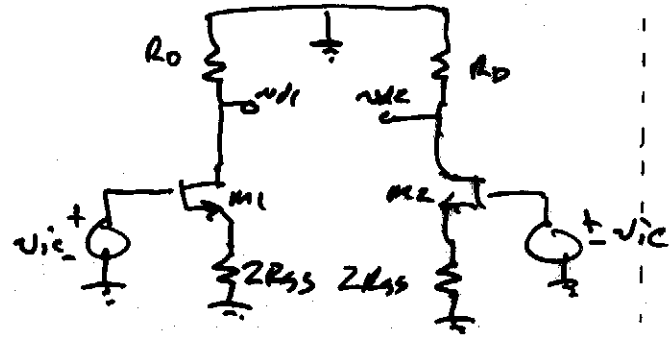


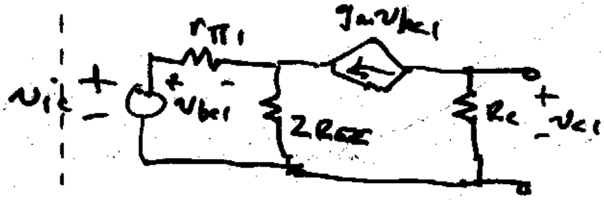
$v_{d1} = -g_m R_D v_{gs1} = -\frac{g_m R_D}{2} v_{id}$

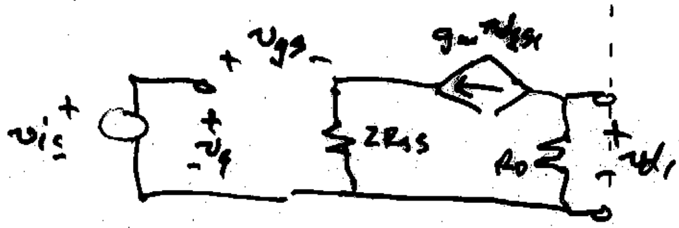
$A_{vd} = \frac{v_{d1}}{v_{id}} = -\frac{g_m R_D}{2} \Rightarrow \frac{v_{od}}{v_{id}} = -g_m R_D$

$R_{id} = \infty$ $\quad R_{od} = 2(R_D \| r_o)$









$$A_{cd} = \frac{v_{c1}}{v_{ic}} = \frac{v_{c1}}{v_{be1}} \frac{v_{be1}}{v_{ic}}$$

$$v_{be1} = v_{b1} - v_{e1}$$
$$= v_{ic} - 2R_{EE}\left(\frac{1}{r_{\pi 1}} + g_{m1}\right) v_{be1}$$

$$\frac{v_{be1}}{v_{ic}} = \frac{1}{1 + \frac{2R_{EE}}{r_\pi}(1+\beta_1)}$$

$$\therefore \frac{v_{c1}}{v_{ic}} = \frac{-g_{m1} R_C}{1 + \frac{2R_{EE}}{r_\pi}(1+\beta_1)}$$

$$\underline{\underline{A_{cd}}} = \frac{-\beta_1 R_C}{r_{\pi 1} + (1+\beta_1) 2R_{EE}}$$

$$R_{ic} = \frac{v_{ic}}{2 i_b} = \frac{r_\pi + (1+\beta) 2R_{EE}}{2}$$

$$CMRR = \frac{|A_{vd}|}{|A_{cd}|} = \frac{g_m R_C}{2\beta_1 R_C}\left[r_\pi + (1+\beta) 2R_{EE}\right]$$

$$CMRR = \frac{1}{2} + \frac{(1+\beta)R_{EE}}{r_\pi} \simeq \underline{\underline{g_m R_{EE}}}$$

$$A_{cd} = \frac{v_{d1}}{v_{ic}} = \frac{v_{d1}}{v_{gs1}} \frac{v_{gs1}}{v_{ic}}$$

$$v_{gs} = v_{ic} - g_m 2 R_{SS} v_{gs}$$

$$\frac{v_{gs}}{v_{ic}} = \frac{1}{1 + 2 g_m R_{SS}}$$

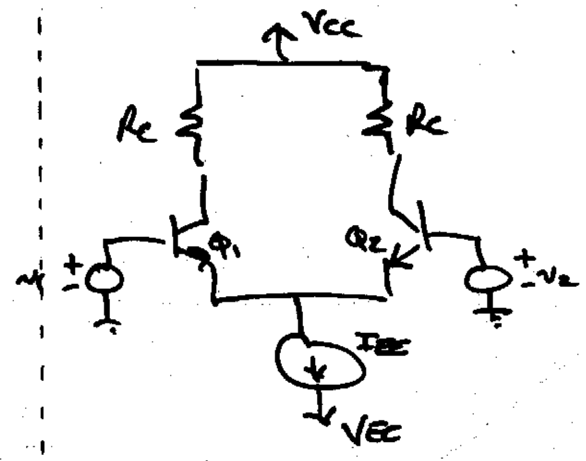
$$\therefore A_{cd} = \frac{g_m R_D}{1 + 2 g_m R_{SS}}$$

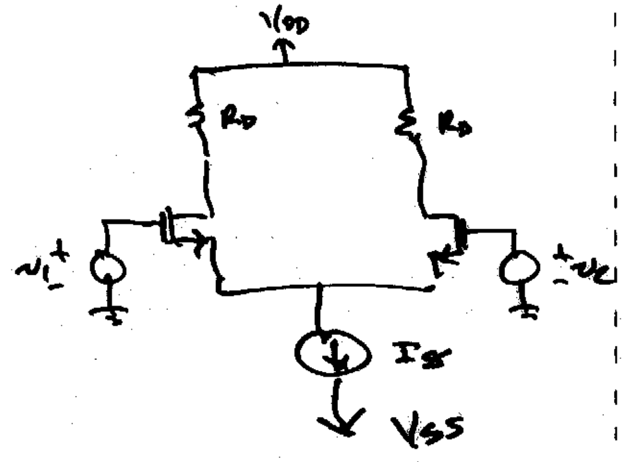
$$R_{ic} = \infty$$

$$CMRR = \frac{|A_{vd}|}{|A_{vc}|} = \frac{g_m R_D / 2}{\frac{g_m R_D}{1 + 2 g_m R_{SS}}}$$

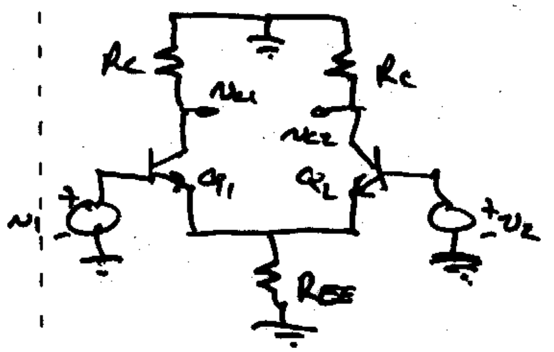
$$\Rightarrow \underline{\underline{CMRR}} \simeq g_m R_{SS}$$

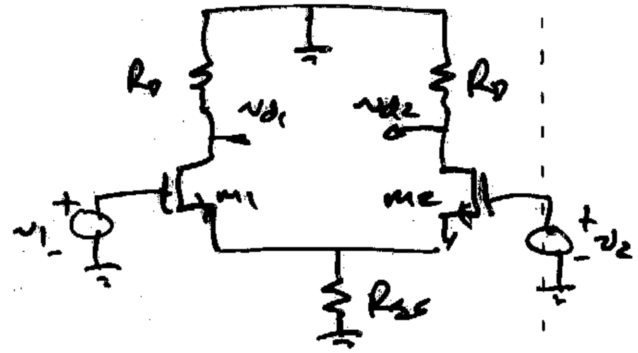
CURRENT SINK BIASING OF DIFFERENTIAL AMPS

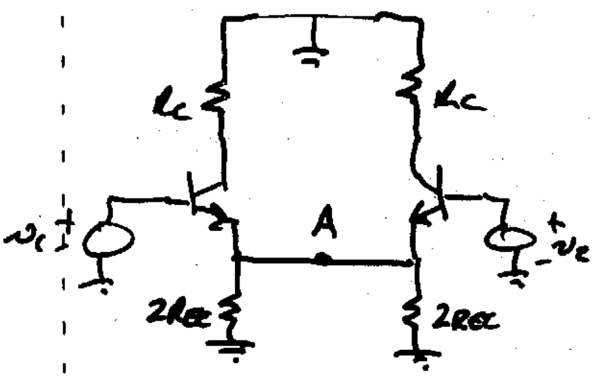


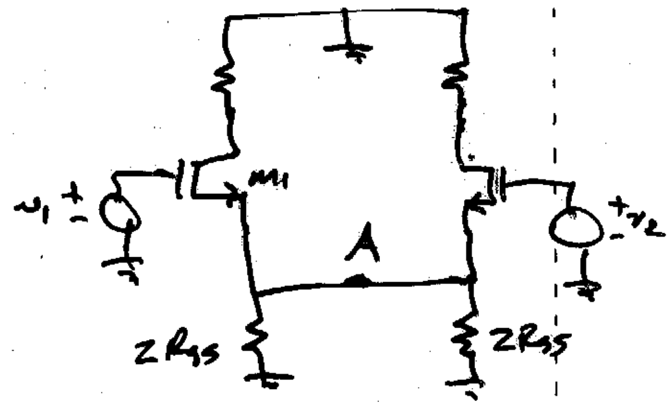


AC CIRCUIT









- For diff. mode analysis (v_{id}), ground 'A' node and repeat previous analysis
- For common mode analysis (v_{ic}), cut the connection at 'A' and repeat previous analysis for half-circuits.

CH. 17

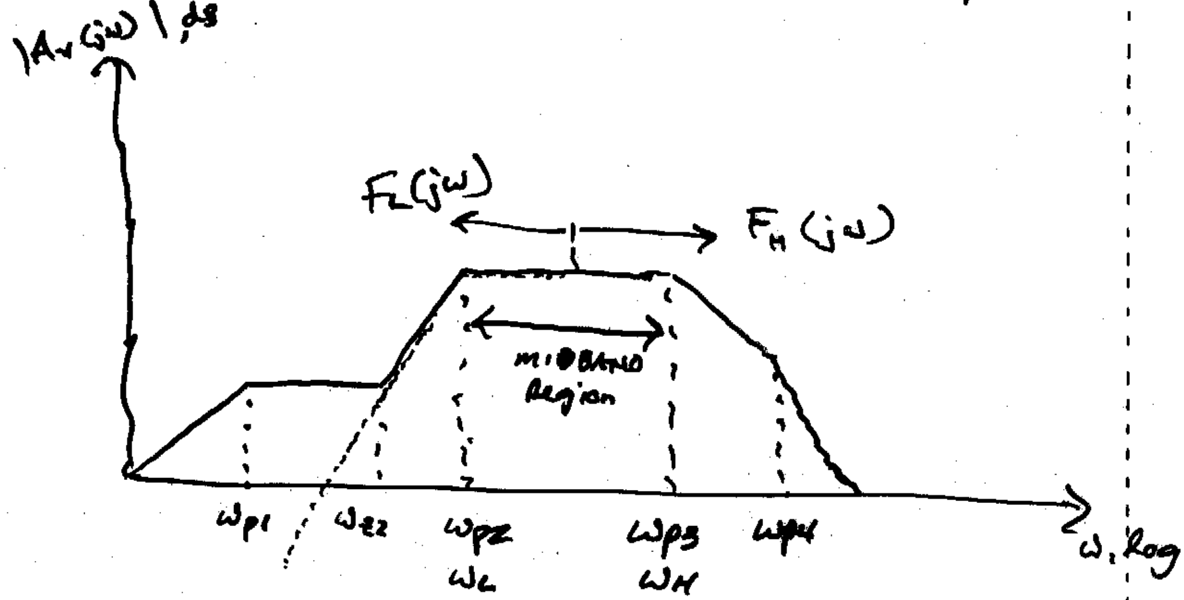
17.1 Amplifier Frequency Response

$$A_v(s) = \frac{a_0 + a_1 s + a_2 s^2 + \ldots + a_m s^m}{b_0 + b_1 s + b_2 s^2 + \ldots + b_n s^n}$$

$$= A_{mid} F_L(s) F_H(s)$$

$$F_L(s) = \frac{(s+\omega_{z1}^L)(s+\omega_{z2}^L)\ldots(s+\omega_{zk}^L)}{(s+\omega_{p1}^L)(s+\omega_{p2}^L)\ldots(s+\omega_{pk}^L)}$$

$$F_H(s) = \frac{(1+\frac{s}{\omega_{z1}^H})(1+\frac{s}{\omega_{z2}^H})\ldots(1+\frac{s}{\omega_{zl}^H})}{(1+\frac{s}{\omega_{p1}^H})(1+\frac{s}{\omega_{p2}^H})\ldots(1+\frac{s}{\omega_{pl}^H})}$$



Low Freq. Response

1.) $\omega_L \simeq \omega_p$ (dominant) if ω_p (dominant) ≥ 4 (next smallest pole)

2.) $\omega_L \simeq \sqrt{\sum_n \omega_{pn}^2 - 2\sum_n \omega_{zn}^2}$ ⇒ estimation in absence of a dominant pole.