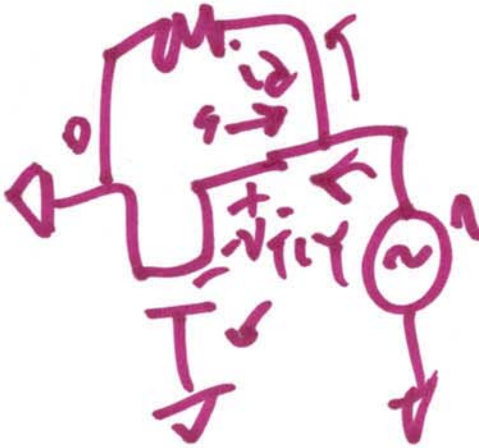
Lecture 18

March 29, 2016

EE 420 / ECG 620

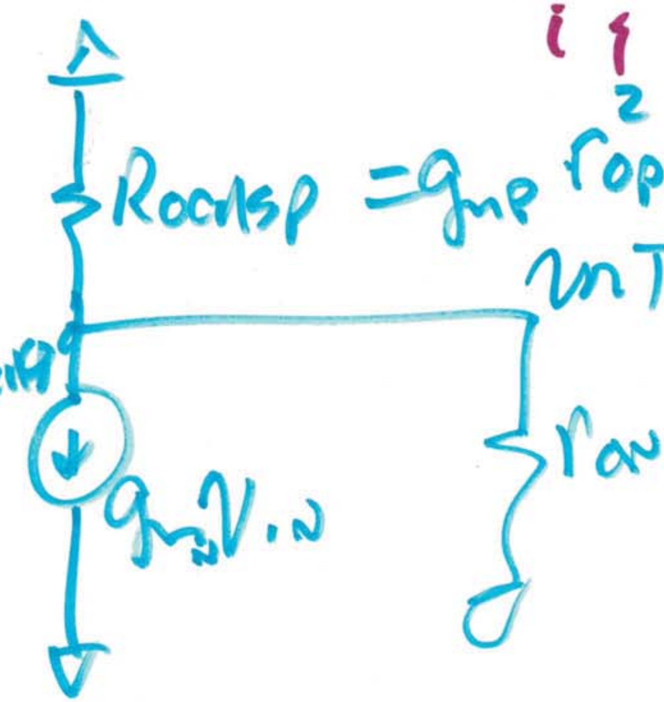
r_o $\quad \frac{v_T}{r_o} + -i_d + i_T = 0$



$$i_T = -\cancel{i_d} + \frac{v_T}{r_o} = v_T\left(\frac{1}{g_m} + \frac{1}{r_o}\right) = i_T$$

$$\frac{v_T}{i_T} = r_o \,\|\, 1/g_m = \frac{1}{1/g_m + r_o}$$

$R_{ocasp} = g_{mp} r_{op}^2$

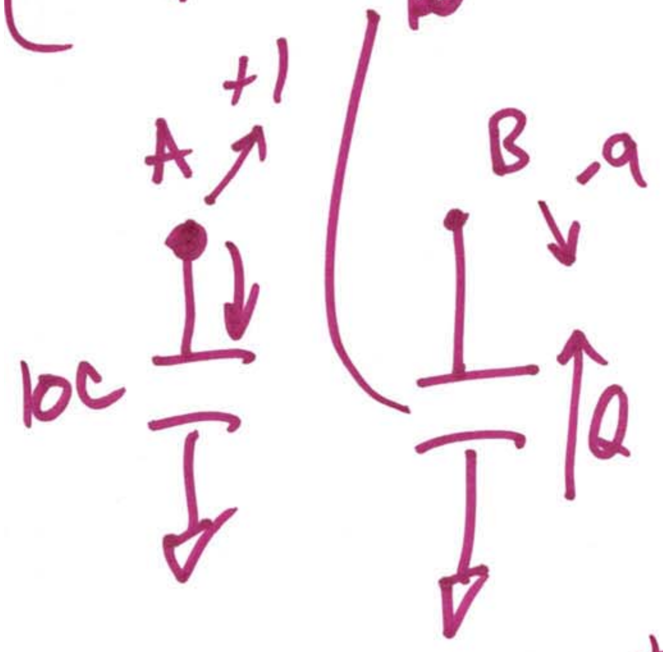


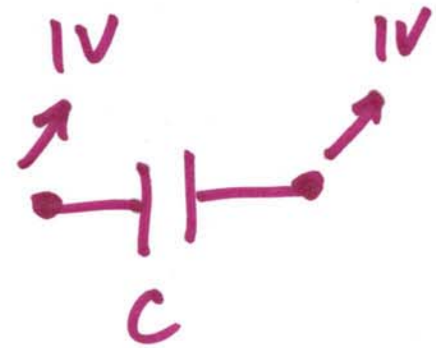
$$\frac{v_{out}}{v_{in}} = -g_{mn} \cdot r_{on} \,\|\, R_{ocasp} \approx -g_{mn} \cdot r_{on}$$

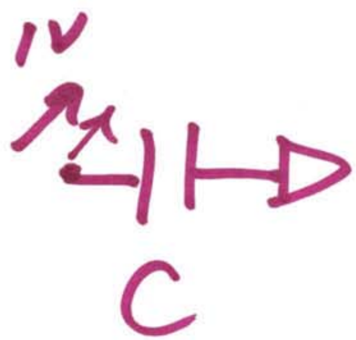
$R_{ocasp} >> r_{on}$

Miller effect

$$\left(1+\frac{1}{9}\right)C = \frac{10}{9}C$$



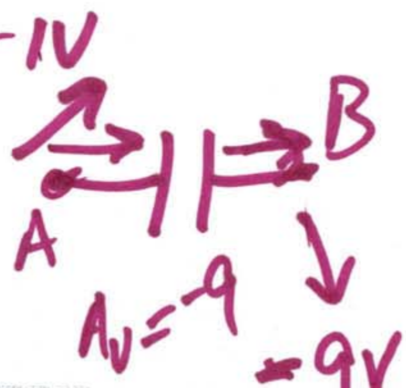




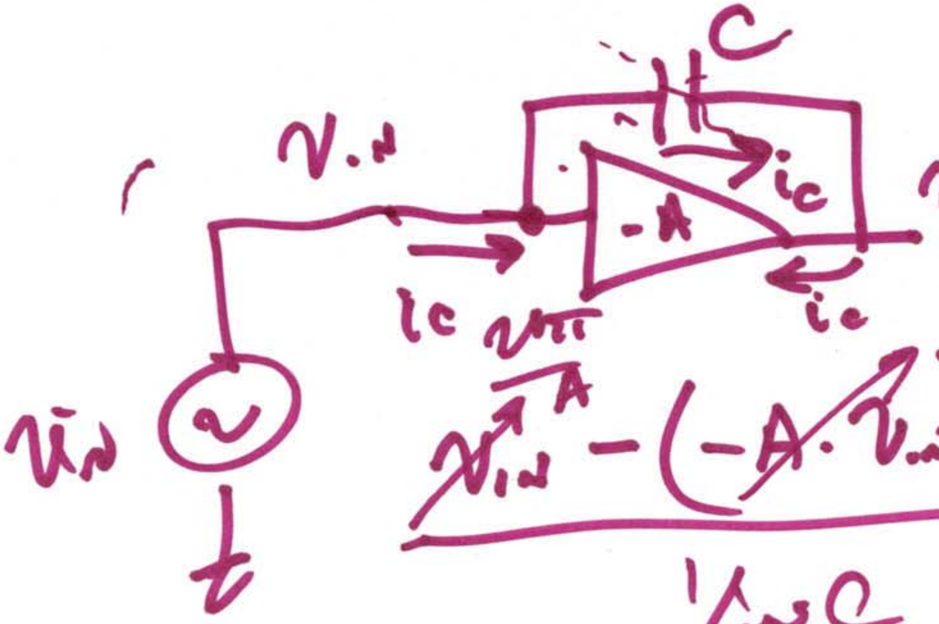
$$Q = C \cdot 1V$$

$$I = \frac{Q}{\Delta t}$$

$$10C = -9 \cdot C_{new}$$

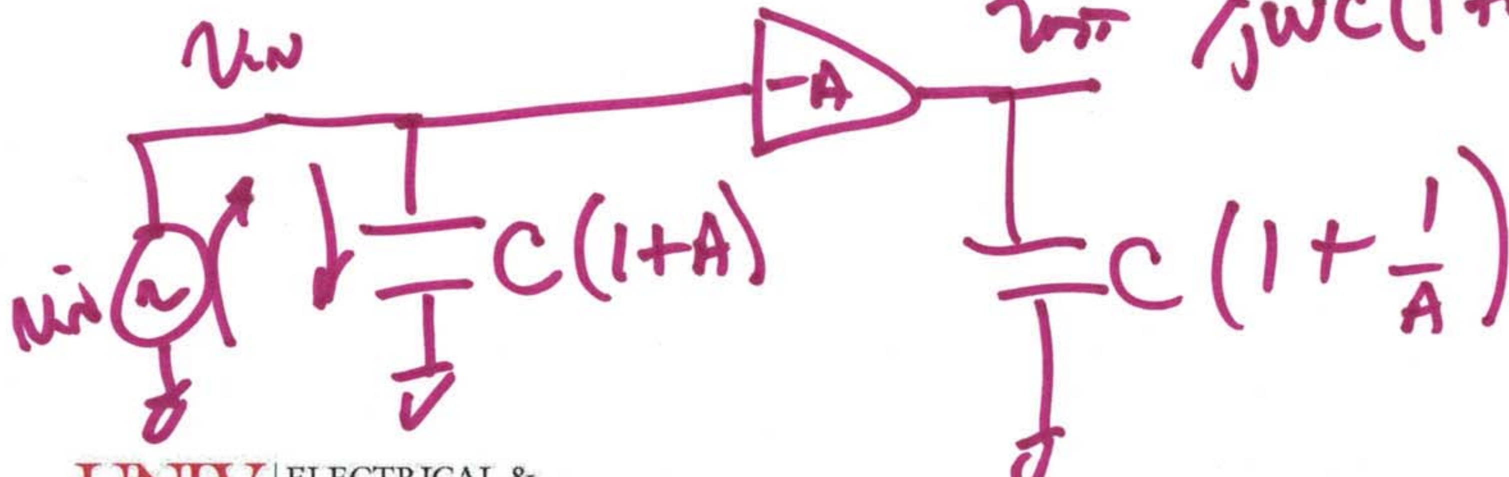


$$Q = C \cdot (1-(-9)) = 10C$$

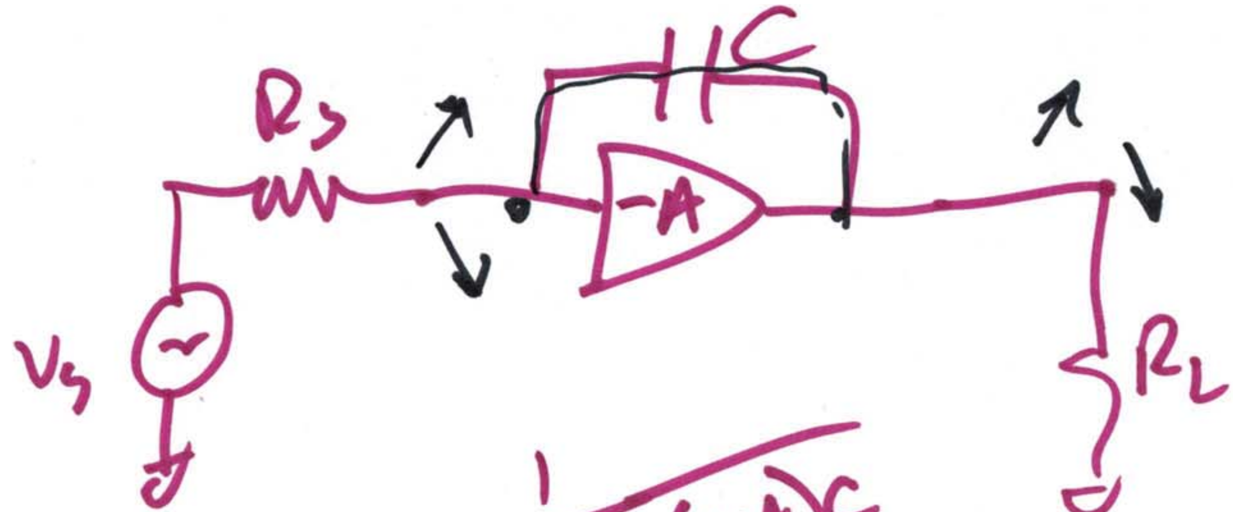


$$\frac{\cancel{v_{in}}^{\,v_{OUT}/A} - \left(-\cancel{A \cdot v_{in}}^{\,v_{OUT}}\right)}{1/j\omega C} = i_c$$

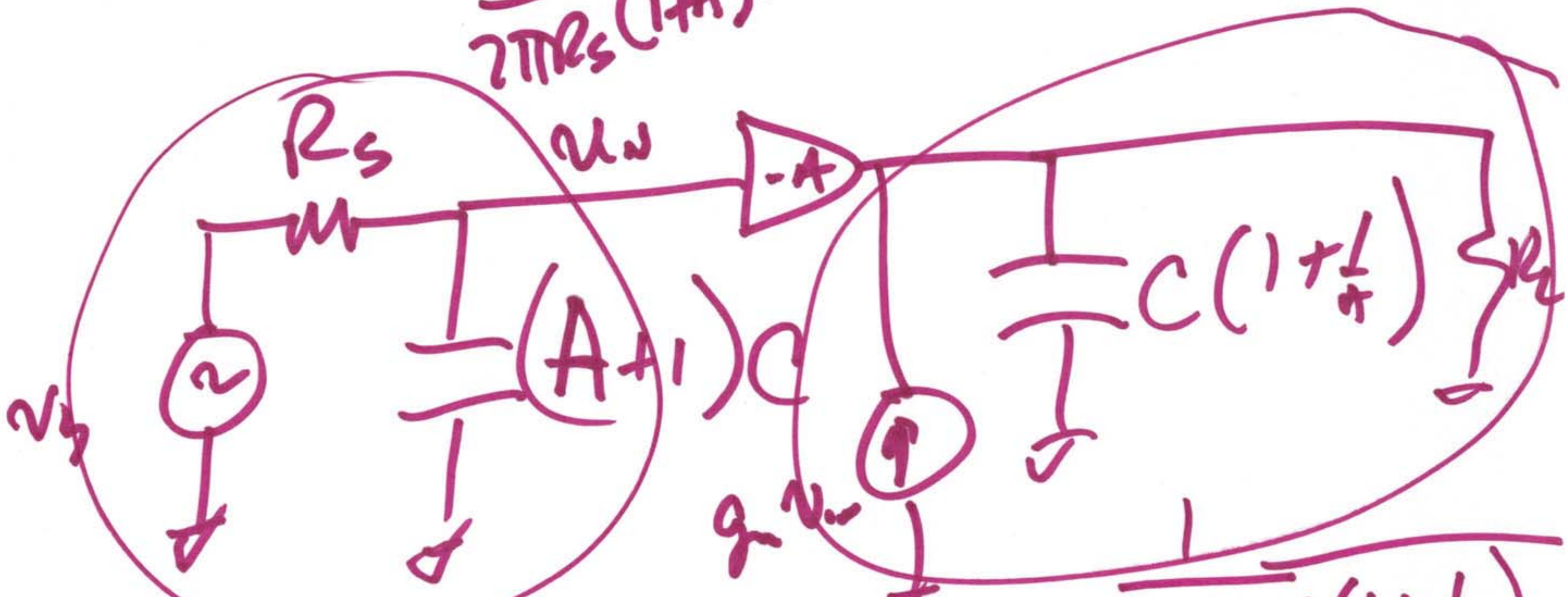
$$\frac{v_{in}}{1/j\omega C(1+A)} = i_c$$



RHP-zero



$$\frac{1}{2\pi R_s(1+A)C}$$



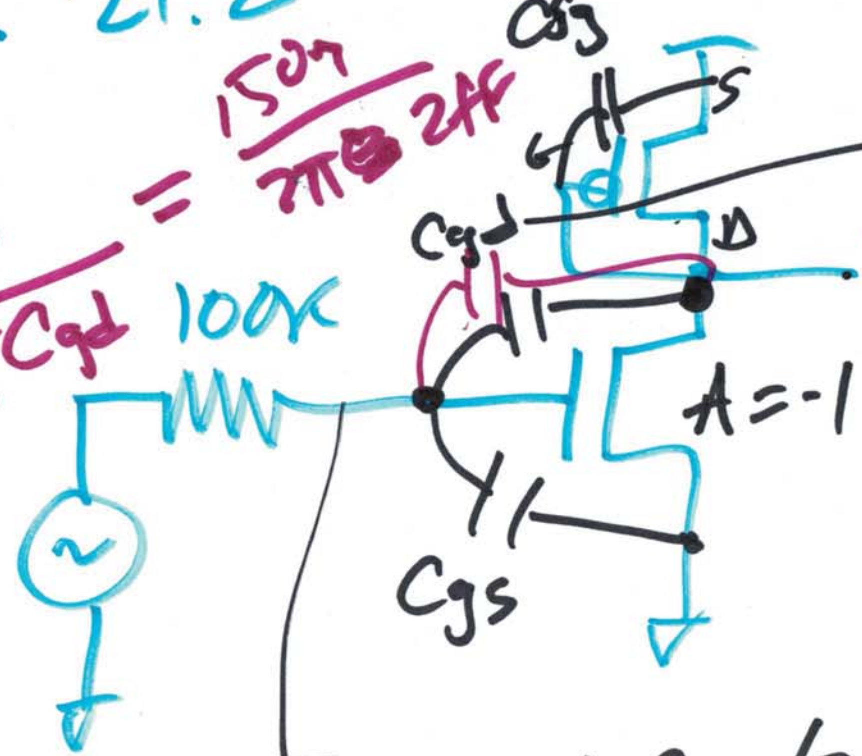
$$\frac{1}{2\pi R_L \cdot C(1+\frac{1}{A})}$$

Ex. 21.2

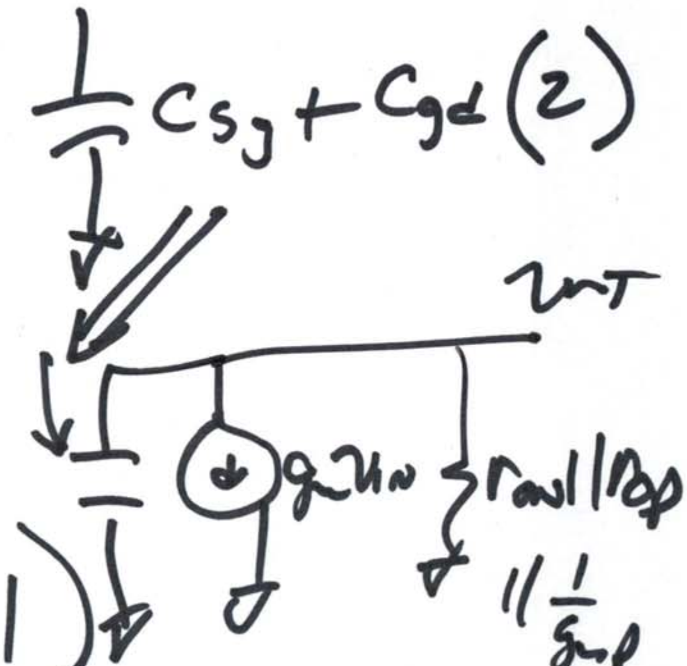
$$f_z = \frac{g_{mN}}{2\pi C_{gd}} = \frac{150\mu}{2\pi \cdot 2fF}$$

$\Downarrow$

11.9 GHz



$\rightarrow C_{gd}\left(1 + \frac{1}{|A|}\right)$

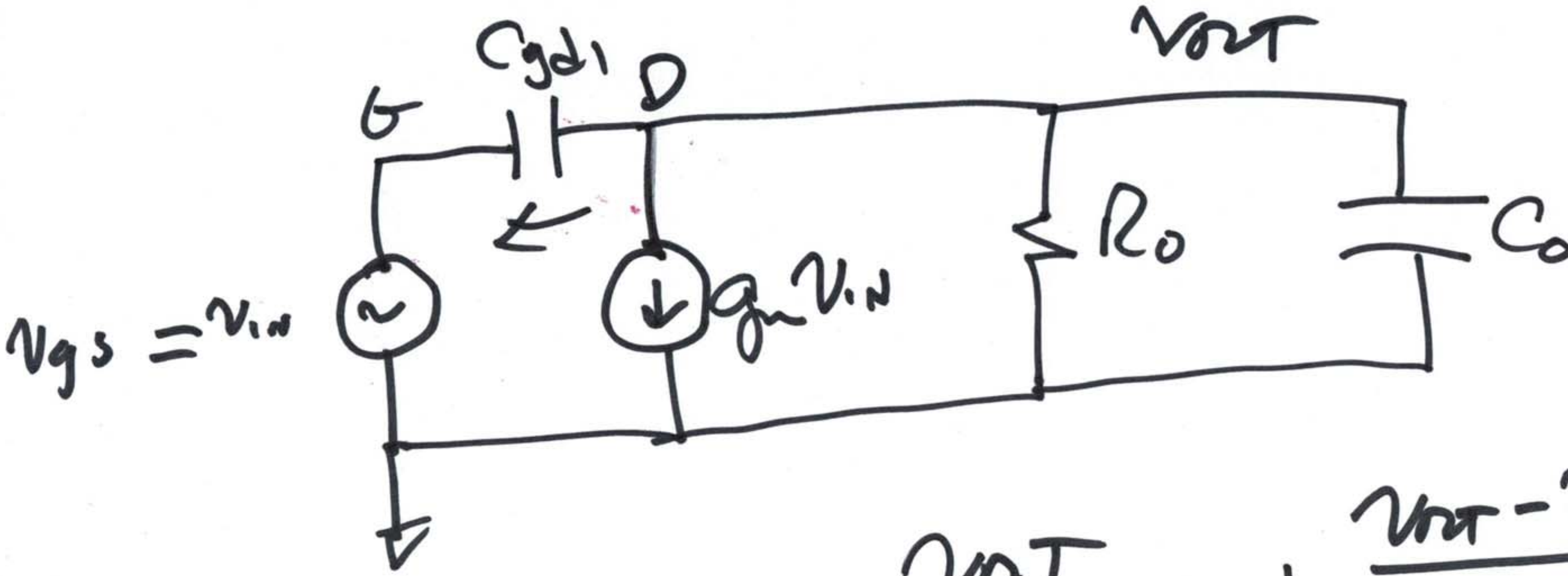


$C_{gs} + C_{gd}(2)$

$(1 + |A|)$

$$f_{in} = \frac{1}{2\pi\, 100k\,(27.3fF)} = 53\ \text{MHz}$$

$$f_{out} = \frac{1}{2\pi \cdot \frac{1}{g_{mp}} \cdot 74fF} = 331\ \text{MHz}$$



$$0 = g_m v_{in} + \frac{v_{out}}{R_o \,||\, 1/j\omega C_o} + \frac{v_{out} - v_{in}}{1/j\omega C_{gd1}}$$

$$-v_{in}\left(g_m - j\omega C_{gd1}\right) = \frac{\left(R_o + \frac{1}{j\omega C_o}\right) v_{out}}{R_o \cdot \frac{1}{j\omega C_o}} + \frac{v_{out}}{\frac{1}{j\omega C_{gd1}}}$$

$$\frac{v_\pi}{v_{in}} = -\frac{g_m - j\omega C_{gd1}}{j\omega C_{gd1} + \dfrac{R_o + \frac{1}{j\omega C_o}}{R_o \cdot \frac{1}{j\omega C_o}}}$$ $\wedge$

$$1 = 2\pi f_z \frac{C_{gd1}}{g_m}$$

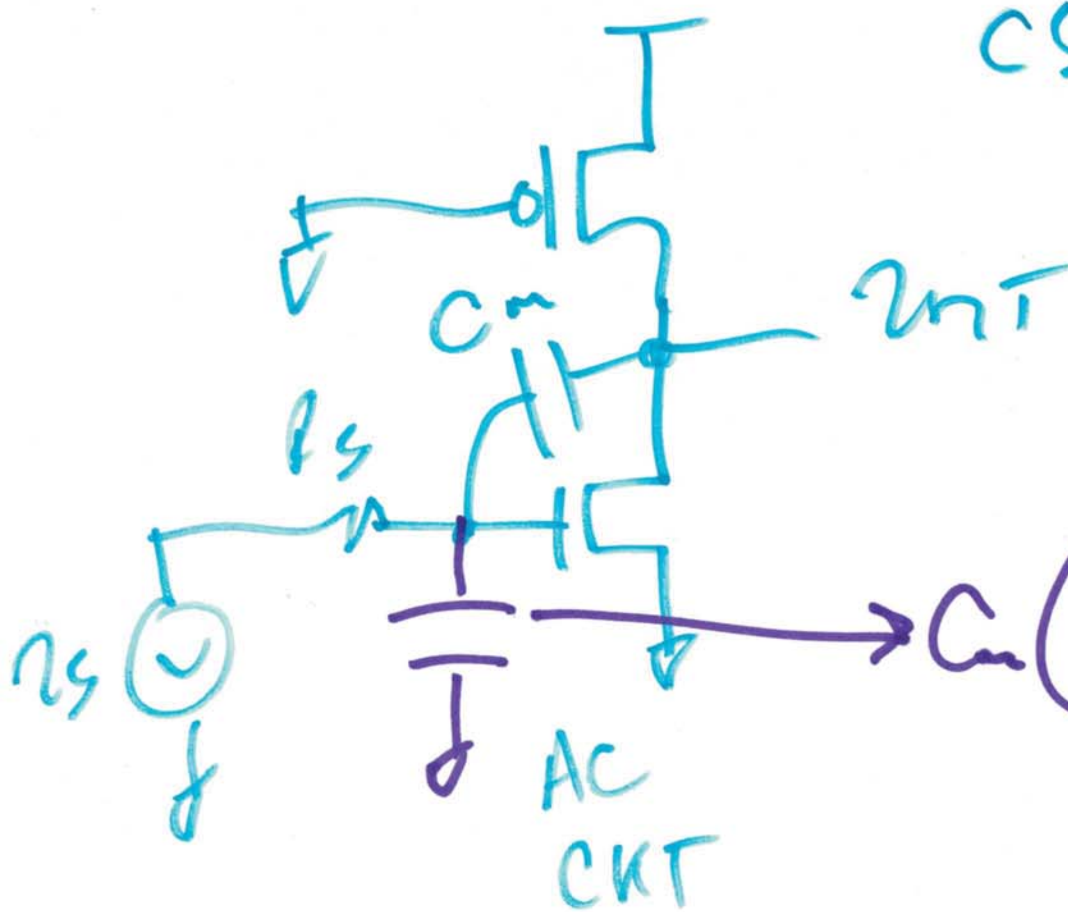
$$\boxed{f_z = \frac{g_m}{2\pi C_{gd1}}} = -g_m R_o \cdot \frac{1 - j\omega \frac{C_{gd1}}{g_m}}{j\omega C_{gd1} \cdot R_o + \dfrac{R_o + \frac{1}{j\omega C_o}}{1/j\omega C_o}}$$

$$1 = 2\pi f_p \cdot (C_{gd1} + C_o) \cdot R_o$$

$$f_p = \frac{1}{2\pi (C_{gd1} + C_o) \cdot R_o} = -g_m R_o \cdot \frac{1 - j\omega \frac{C_{gd1}}{g_m}}{1 + j\omega (C_{gd1} + C_o) \cdot R_o}$$

$$f_z = \frac{1}{2\pi 10p \cdot \frac{1}{g_m R}}$$

CS w current mirror



$A_v = -g_{mn} \cdot r_{on} || r_{op}$

$\rightarrow C_m(1 + g_m \underline{r_{on}||r_{op}})$