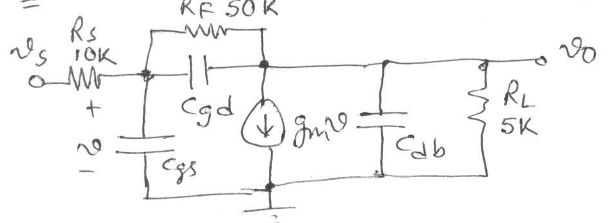
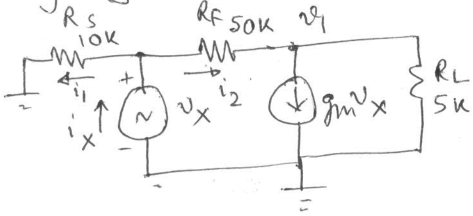
1. C_{sb} would be absent. $C_{gs} = \frac{2}{3}WLC_{ox}' = 93.3$ fF. $g_m = \sqrt{2K_n I_D} = 1.732$ m℧



Three capacitors; three time constants.
v_s goes to gnd in ZVTC method.
∴ for C_{db}: $R_{db}^o = R_L = 5K \Rightarrow \tau_1 = C_{db}R_{db}^o = 0.1$ ns
For C_{gd}: $R_{gd}^o = R_F \| R_{eq}$, where R_{eq} is that of 3-legged creature $\Rightarrow R_{eq} = R_S + R_L + g_m R_L R_S = 101.6K \Rightarrow R_{gd}^o = 33.5$ kΩ $\Rightarrow \tau_2 = C_{gd}R_{gd}^o = 469.13$ ps. For C_{gs}, the eqv. ckt. is not of a standard form:



$i_1 = \frac{v_x}{R_S}$, $i_2 = \frac{v_x - v_1}{R_F} = g_m v_x + \frac{v_1}{R_L} \Rightarrow i_2 = \frac{1+g_mR_L}{R_L+R_F}v_x$

& $i_x = i_1 + i_2 \Rightarrow R_{gs}^o = R_S \| \frac{R_L+R_F}{1+g_mR_L} = 3.63$ kΩ

$\Rightarrow \tau_3 = C_{gs}R_{gs}^o = 338.5$ pS $\Rightarrow \Sigma\tau = 907.63$ pS $\Rightarrow f_H = \frac{1}{2\pi\Sigma\tau} = 175.35$ MHz & $t_r = \frac{0.35}{f_H} = 2$ ns

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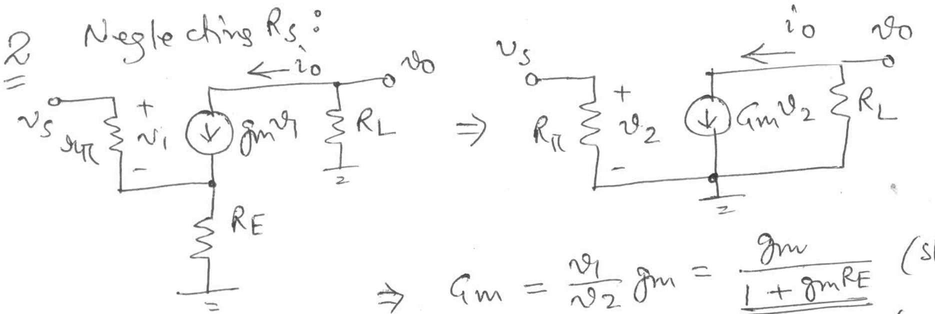
2. Neglecting R_S:



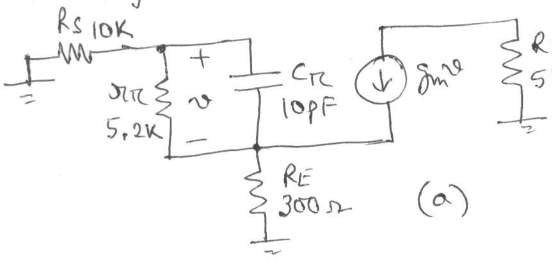
Comparing the 2 figs., $i_o = g_m v_1 = G_m v_2$

$v_1 = \frac{r_\pi}{r_\pi + (\beta+1)R_E} v_s \simeq \frac{v_s}{1+g_mR_E}$. Also, $v_2 = v_s$

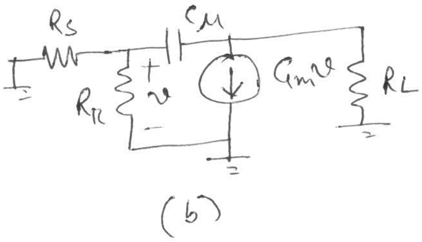
$\Rightarrow G_m = \frac{v_1}{v_2} g_m = \frac{g_m}{1+g_mR_E}$ (shown)

Also, $R_\pi = r_\pi + (\beta+1)R_E \simeq r_\pi + g_m r_\pi R_E = r_\pi(1+g_mR_E)$ (shown)

Now, for the freq. resp., $r_E = 26\,\Omega$, $r_\pi = 5.2K$, $C_\mu = 0.2$pF, $C_\pi = \frac{g_m}{2\pi f_T} - C_\mu = 10$ pF



(a)



(b)

For C_π, refer to Fig. (a): It is a standard form, with $R_\pi^o = r_\pi \| \frac{R_S+R_E}{1+g_mR_E} = 709.4\,\Omega$

$\Rightarrow \tau_1 = R_\pi^o C_\pi = 7.09$ ns

For C_μ, refer to Fig. (b), with $R_\pi = r_\pi(1+g_mR_E) = 65.2$ kΩ, & $G_m = \frac{g_m}{1+g_mR_E} = \frac{1}{326}$ ℧, the resultant structure is a 3-legged creature, with $R_\mu^o = R_{eq} + R_L + G_m R_{eq} R_L$, where $R_{eq} = R_S \| R_\pi = 8.67$ kΩ $\Rightarrow R_\mu^o = 146.65$ kΩ $\Rightarrow \tau_2 = R_\mu^o C_\mu = 29.33$ ns $\Rightarrow \Sigma\tau = 36.42$ ns $\Rightarrow f_H = 4.37$ MHz & $t_r = 80.1$ ns [$f_H = 1/(2\pi\Sigma\tau)$, & $t_r = 0.35/f_H$].

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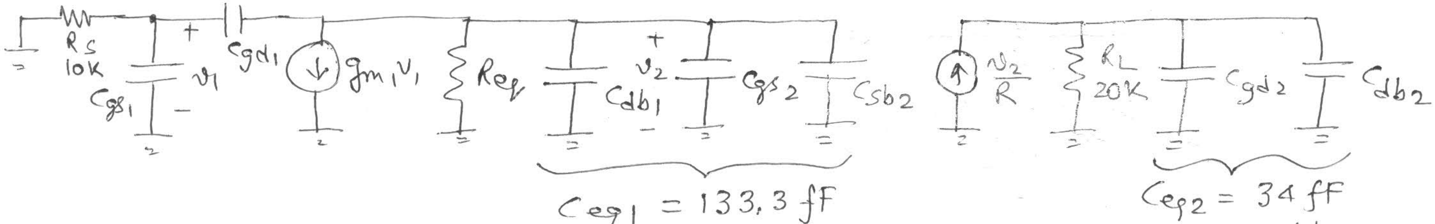
3. R_S plays no role in midband gain calculation, ∵ the gate is open-ckt. $g_{m1} = g_{m2} = 1.732$ m℧ (same as Prob. 1), & $g_{mb2} = \chi_2 g_{m2} = 346.4$ μ℧ ($\chi_2 = 0.2$)

Gain of $M_1 = -\frac{g_{m1}}{g_{m2}+g_{mb2}} = -\frac{1}{1+\chi_2} = -0.83$ & Gain of $M_2 = +(g_{m2}+g_{mb2})R_L = +41.57$

∴ Overall voltage gain $= -0.83 \times 41.57 = -34.5$.

[Note: For freq. resp., C_{sb} would not play any role, rest all capacitors would be present]



After clubbing the capacitors, we would have 4 time consts. for the ckt. $R^o_{gs_1} = R_S = \underline{10K} \Rightarrow \tau_1 = C_{gs_1} R^o_{gs_1} = \underline{933\ pS}$. $R^o_{gd_1} = R_S + R_{eq} + g_{m_1} R_S R_{eq}$, where $R_{eq} = (g_{m_2} + g_{mb_2})^{-1} = \underline{481.14\ \Omega} \Rightarrow R^o_{gd_1} = \underline{18.8\ k\Omega} \Rightarrow \tau_2 = C_{gd_1} R^o_{gd_1} = \underline{263.4\ pS}$. $R^o_{eq_1} = R_{eq} = \underline{481.14\ \Omega} \Rightarrow \tau_3 = C_{eq_1} R^o_{eq_1} = \underline{64.14\ pS}$, & $R^o_{eq_2} = R_L = \underline{20K} \Rightarrow \tau_4 = C_{eq_2} R^o_{eq_2} = \underline{680\ pS} \Rightarrow \Sigma\tau = \underline{1.94\ nS} \Rightarrow f_H = \frac{1}{2\pi \Sigma\tau} = \underline{82\ MHz}$, & $t_r = \frac{0.35}{f_H} = \underline{4.27\ nS}$

×

4 $I_{C_1} = \underline{1\ mA}$, & with EB area of Q_2 4 times that of $Q_1 \Rightarrow I_{C_2} = \underline{4\ mA}$ $\therefore r_{E_1} = 26\ \Omega$, $r_{\pi_1} = 5.2\ K\Omega$, $r_{E_2} = 6.5\ \Omega$, & $r_{\pi_2} = \underline{1.3\ K\Omega}$. Q_1 is diode connected $\Rightarrow$ the net resistance "seen" by $i_i = r_{E_1} \| r_{\pi_1} \| r_{\pi_2} = 26 \| 5.2K \| 1.3K = \underline{25.37\ \Omega} \Rightarrow$ Voltage drop across this comb$^{\underline{n}}$, $v = \underline{25.37\ i_i}$. Output current $i_o = g_{m_2} v = 25.37\ i_i / r_{E_2} = \underline{3.9\ i_i} \Rightarrow$ Midband current gain $i_o/i_i = \underline{3.9}$, with the i/p & o/p currents in phase. For freq. resp., $C_{\pi_1} = C_{je} + \tau_F g_{m_1} = \underline{8.7\ pF}$, $C_{\pi_2} = \underline{34.77\ pF}$. C_{μ_1} is absent (Base - Collector short), C_{μ_2} appears betn i/p & o/p. C_{π_1} & C_{π_2} are in $\|^{l} \Rightarrow$ net $C_\pi = C_{\pi_1} + C_{\pi_2} = \underline{43.47\ pF}$. Now, $R^o_\pi = r_{E_1} \| r_{\pi_1} \| r_{\pi_2} = \underline{25.37\ \Omega} \Rightarrow \tau_1 = R^o_\pi C_\pi = \underline{1.1\ nS}$. $R^o_{\mu_2}$ is also equal to R^o_π (by inspection) $\Rightarrow \tau_2 = R^o_{\mu_2} C_{\mu_2} = \underline{20.3\ pS}$ (note τ_2 is so much smaller than τ_1, that C_{μ_2} would not play any role in determining the cutoff freq. of the ckt) $\Sigma\tau = \underline{1.12\ nS}$ $\Rightarrow f_H = \underline{142.1\ MHz}$ (very large), & $t_r = \underline{2.46\ nS}$.

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... Q_{13} & Q_{13B} both saturate, then an abnormally ... 100 Ω resistor (R_8)