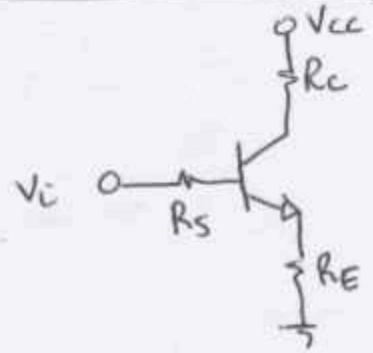
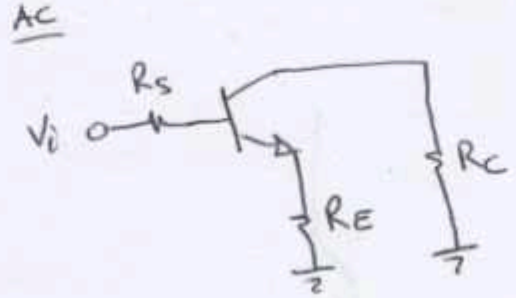
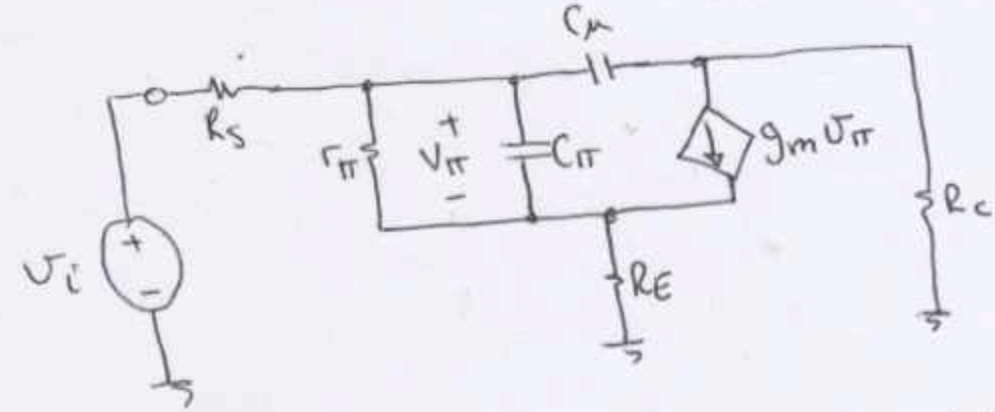
CE with emitter degeneration

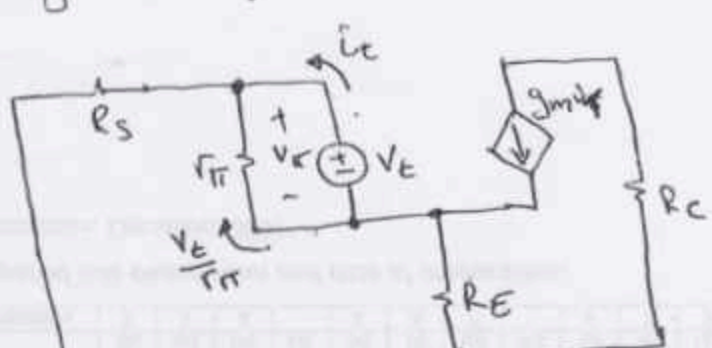




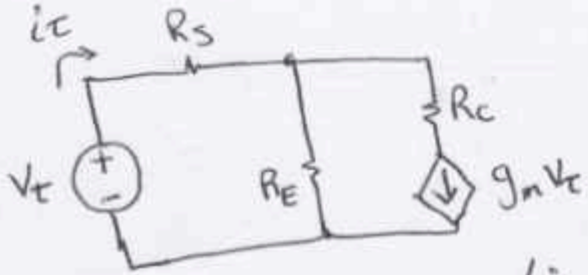


In this case it is not convenient to apply Miller's therem.
So use time constant method directly.
Replace C_μ with o.c. and find Req. from C_π terminals.
V_i should be replaced with a short, since we are calculating an equivalent resistance.

$v_\pi = v_t$



$$C_\pi: \; R_{eq} = R_\pi = r_\pi \,||\, R'_{eq}$$



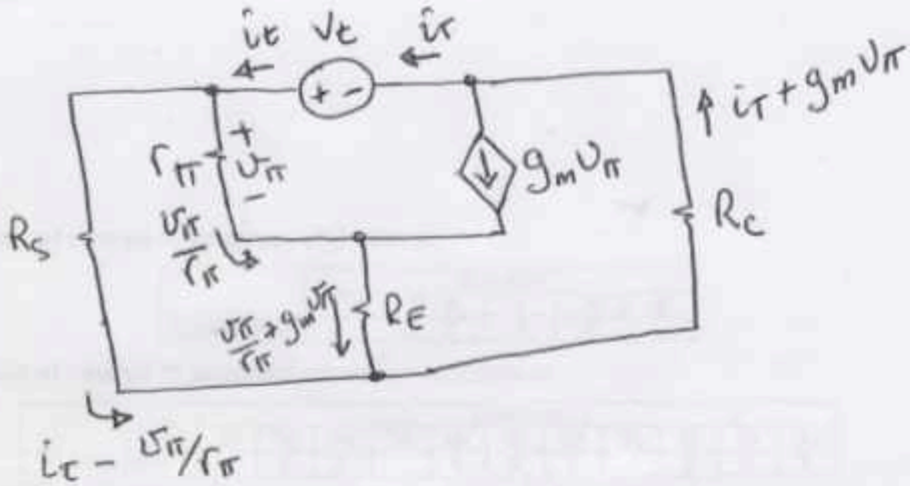
$$v_t = i_t R_S + (i_t - g_m v_t) R_E$$

$$v_t (1 + g_m R_E) = i_t (R_S + R_E)$$

$$R'_{eq} = \frac{v_t}{i_t} = \frac{R_S + R_E}{1 + g_m R_E}$$

$$\boxed{R_\pi = r_\pi \,\|\, \frac{R_S + R_E}{1 + g_m R_E}}$$

Now replace C_π with an o.c. and find equiv. resistance from C_μ terminals $= R_\mu$.



① $V_t = R_s\left(i_t - \frac{v_\pi}{r_\pi}\right) + R_c\left(i_t + g_m v_\pi\right)$

② $V_t = v_\pi + \left(\frac{1}{r_\pi} + g_m\right) R_e v_\pi + R_c\left(i_t + g_m v_\pi\right)$

$$R_s\left(i_t - \frac{v_\pi}{r_\pi}\right) - v_\pi - \left(\frac{1}{r_\pi} + g_m\right) R_e v_\pi = 0$$

$$R_s i_t = v_\pi\left(\frac{R_s}{r_\pi} + 1 + \frac{R_e}{r_\pi} + g_m R_e\right)$$

$$= v_\pi\left(\frac{R_s + R_e + r_\pi + \beta R_e}{r_\pi}\right)$$

$$= \frac{v_\pi}{r_\pi}\left(R_s + r_\pi + (\beta+1)R_e\right)$$

$$v_\pi = i_t \frac{R_s r_\pi}{R_s + r_\pi + (\beta+1)R_e}$$

From ①

$$V_t = i_t(R_s + R_c) + \left(g_m R_c - \frac{R_s}{r_\pi}\right) v_\pi$$

$$= i_t(R_s + R_c) + i_t \frac{\beta R_c - R_s}{r_\pi} \frac{R_s r_\pi}{R_s + r_\pi + (\beta+1)R_e}$$

$$R_\mu = \frac{V_t}{i_t} = R_s + R_c + \frac{\beta R_c R_s - R_s^2}{R_s + r_\pi + (\beta+1)R_E}$$

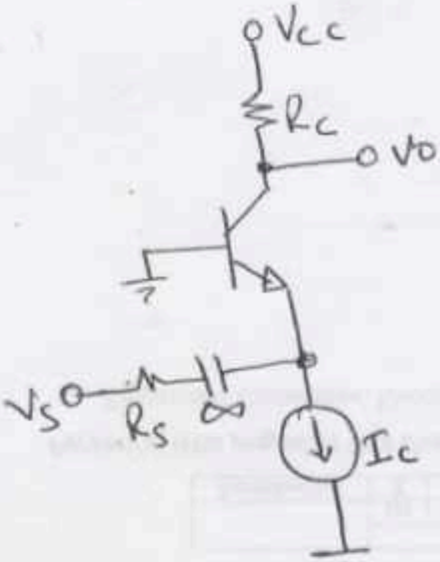
$$R_\mu = R_C + \frac{\cancel{R_S^2} + R_S r_\pi + (\beta+1)R_E R_S + \beta R_C R_S - \cancel{R_S^2}}{R_S + r_\pi + (\beta+1)R_E}$$

$$R_\mu = R_C + \left[\frac{r_\pi + (\beta+1)R_E + \beta R_C}{R_S + r_\pi + (\beta+1)R_E}\right] R_S$$

$$\tau = C_\mu R_\mu + C_\pi R_\pi$$

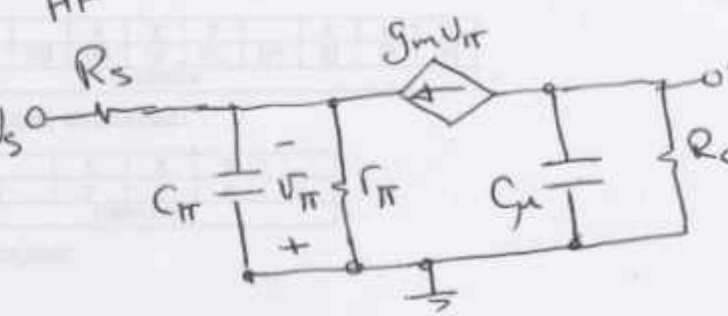
$$\omega_H = \frac{1}{\tau}$$

CB/CG



AC

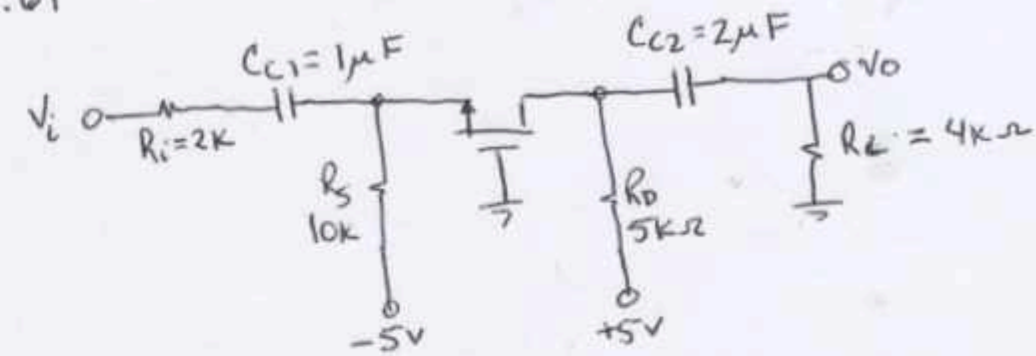
HF



$$R_\pi = R_s || r_\pi || 1/g_m = R_s || \frac{r_\pi}{\beta+1}$$

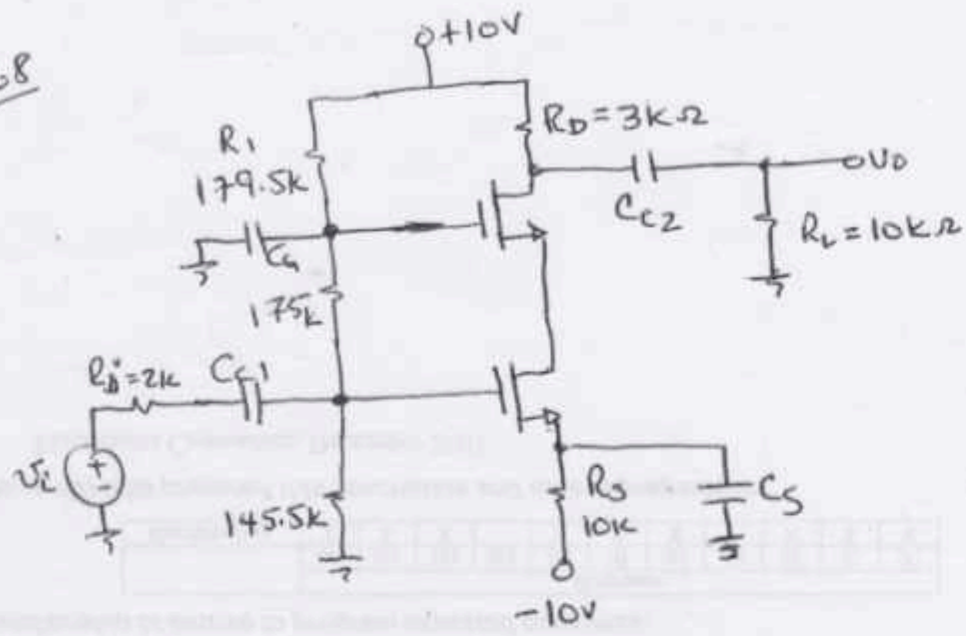
$$R_\mu = R_c$$

P. 7.61

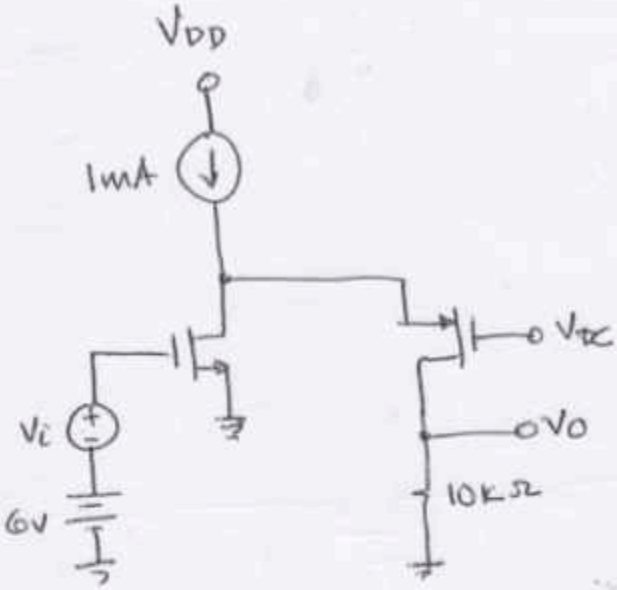


$V_{TN} = 1V$, $K_n = 3\ mA/V^2$, $\lambda = 0$, $C_{gs} = 15pF$
$C_{gd} = 4pF$. Find upper 3dB freq. and Midband gain. Do low freq. also.

P.7.68



$K_n = 1.2\ mA/V^2$; $V_{TN} = 2V$, $\lambda = 0$, $C_{gs} = 5pF$
$C_{gd} = 0.8pF$.
Prob. asks for spice simulation. Find analytical estimates for ω_H and midband voltage gain



$C_{gs} = 30pF$, $C_{gd} = 3pF$, $V_{TN} = 1V$, $V_{TP} = -1V$

$K_n = 20\mu A/V^2$