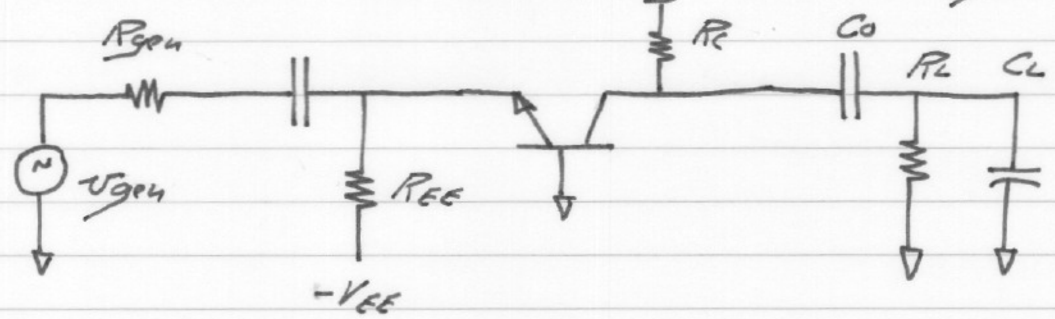
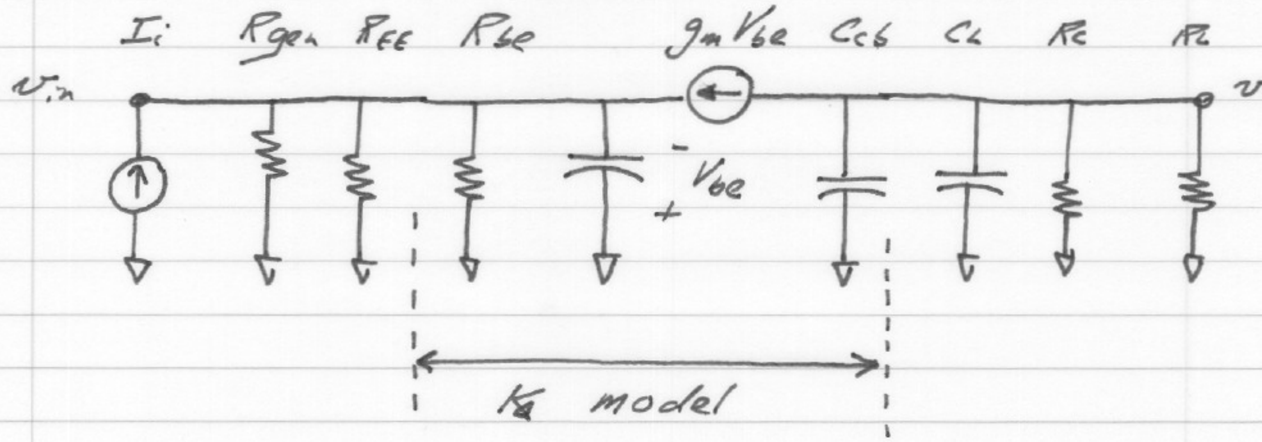
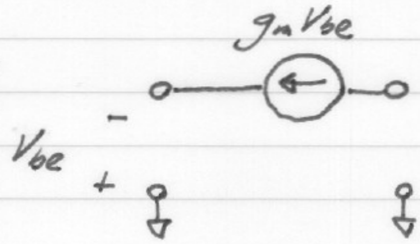
ECE137B Notes set 5: CB & CG stages:



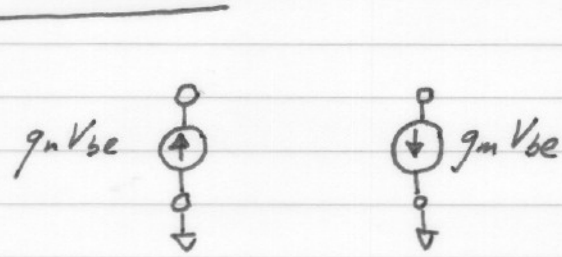
we will neglect Rce in h.f. analysis; usually negligible effect unless RL is very large.



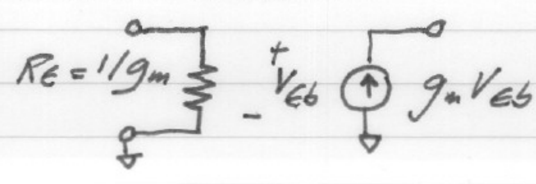
Noting that



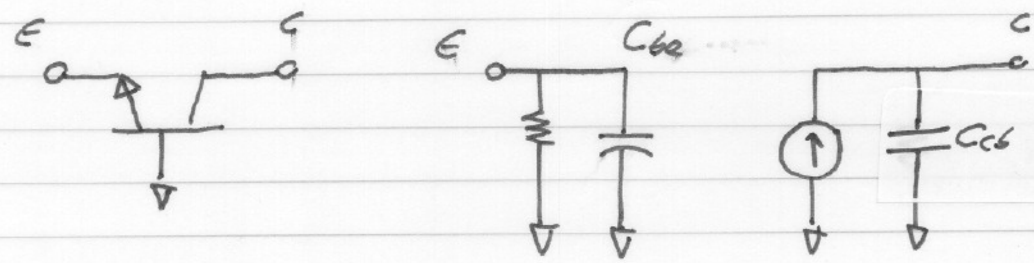
Is exactly equivalent to



which in turn transforms to



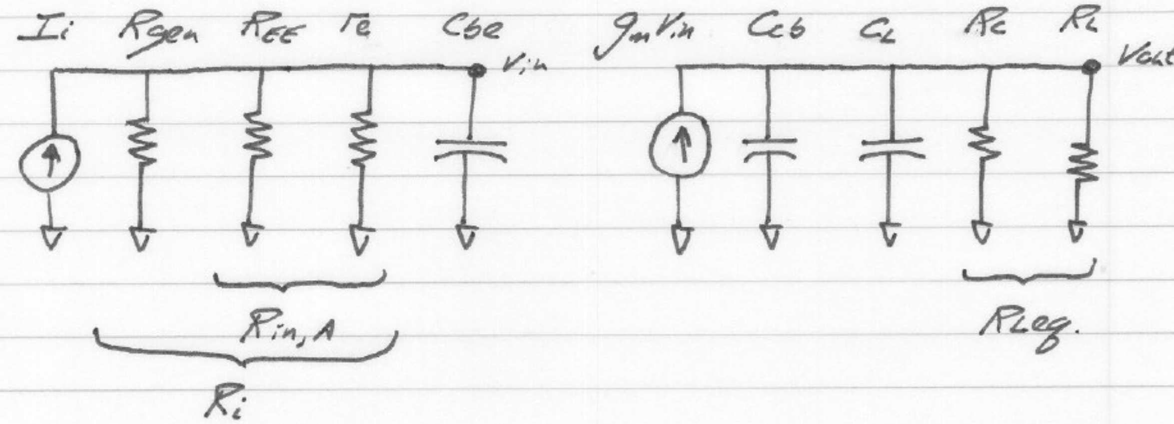
we can model the common-base K_e as so:



$r_e = 1/g_m$ $\qquad g_m V_E = g_m V_{in}$

This is the common-base T-model

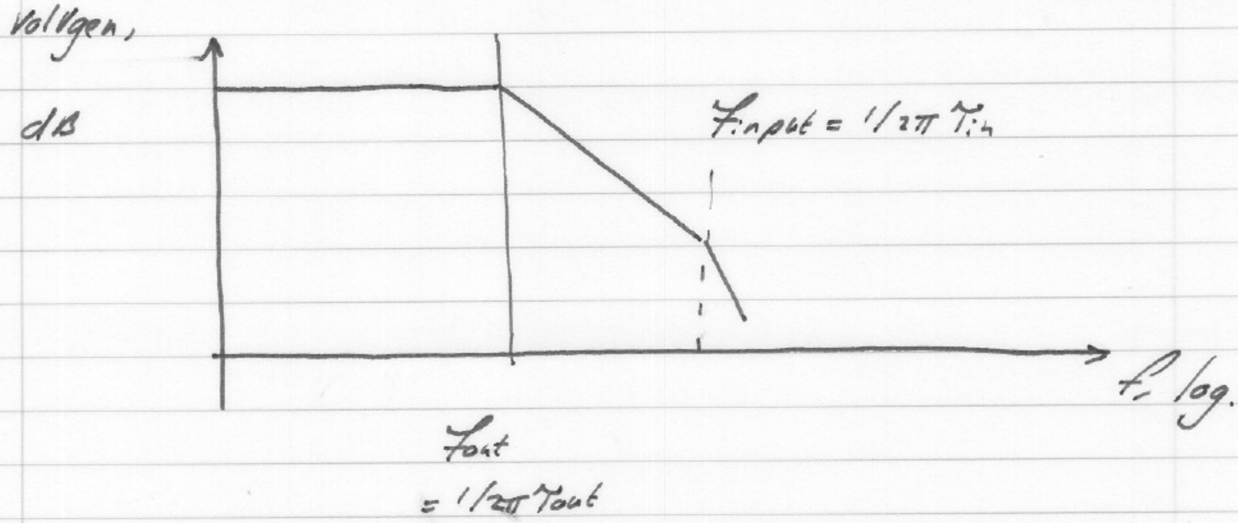
using the T-model, the circuit is modeled thus



$v_i/v_{gen} = v_{in}/v_{gen}\big|_{MB} \cdot \dfrac{1}{1 + s\,\tau_{in}}$; $\tau_{in} = R_i \cdot C_{be}$

$v_o/v_i = v_o/v_i\big|_{MB} \cdot \dfrac{1}{1 + s\,\tau_{out}}$; $\tau_{out} = (C_{cb} + C_L)\,R_{Leq}$.

Analysis is much more complex if R_{bb} is included.



Note $f_{input} = 1/2\pi\tau_{in}$ => is higher than f_T!

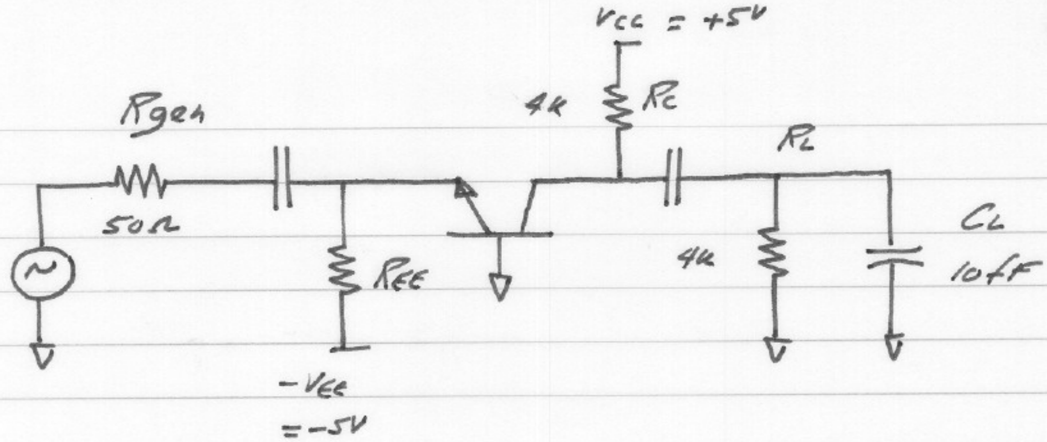
Model is only good up to f_T →

input pole "somewhere around f_T"

To the level we have analyzed it, the CB stage.

- is limited by the output pole
- has no interaction between input & output.
- is simple to analyze.

However, the effect of R_{bb}, neglected for simplicity, is in fact large and seriously effects c.b. bandwidth. This is mostly beyond the scope of the course, although it can be analyzed by the M.O.T.C., to be covered later.



Q_1 parameters $V_A = \infty V$, $\beta = 200$, $f_T = 100\,GHz$, $C_{cb} = 10\,fF$

$V_{BE} = 0.9V$ @ $I_E = 1mA$

BIAS

$I_E = 5.9V / R_{EE} = 1mA \rightarrow R_{EE} = 5.9\,K\Omega$

$V_C = V_{CC} - I_C R_C = +1V.$

Low Frequency analysis

$R_{Leq} = R_C \parallel R_L = 2K\Omega$

$r_e = 1/g_m = 26\Omega$

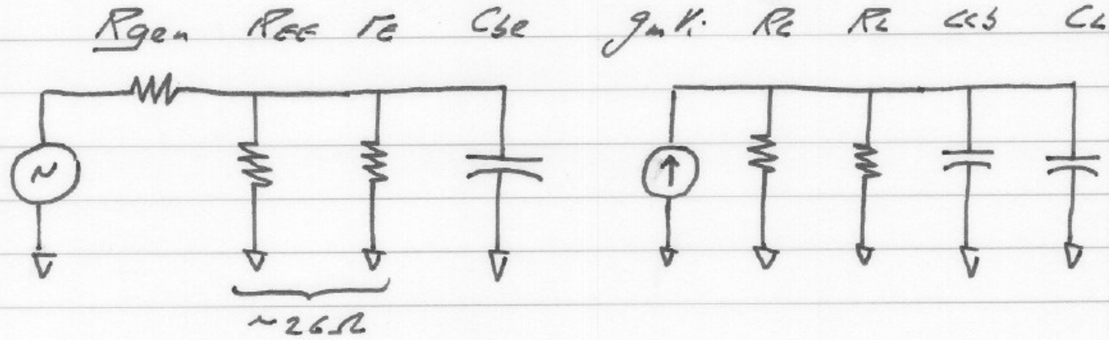
$r_{inT} = r_e = 26\Omega$

$v_o/v_i|_{MB} = R_{Leq}/r_{inT} = 77$

$r_{inA} = r_{inT} \parallel R_{EE} = 25.9\Omega \cong 26\Omega$

$v_{in}/v_{gen} = r_{inA}/(r_{inA} + r_{gen}) = 0.34$

$v_o/v_{gen} = 26.3$



$$C_{be} = \frac{g_m}{2\pi f_T} - C_{cs} = 51\ fF$$

$f_{input} = 1/2\pi\, \tau_{in}$; $\tau_{in} = C_{be}(R_{gen} \| R_{EE} \| r_e)$

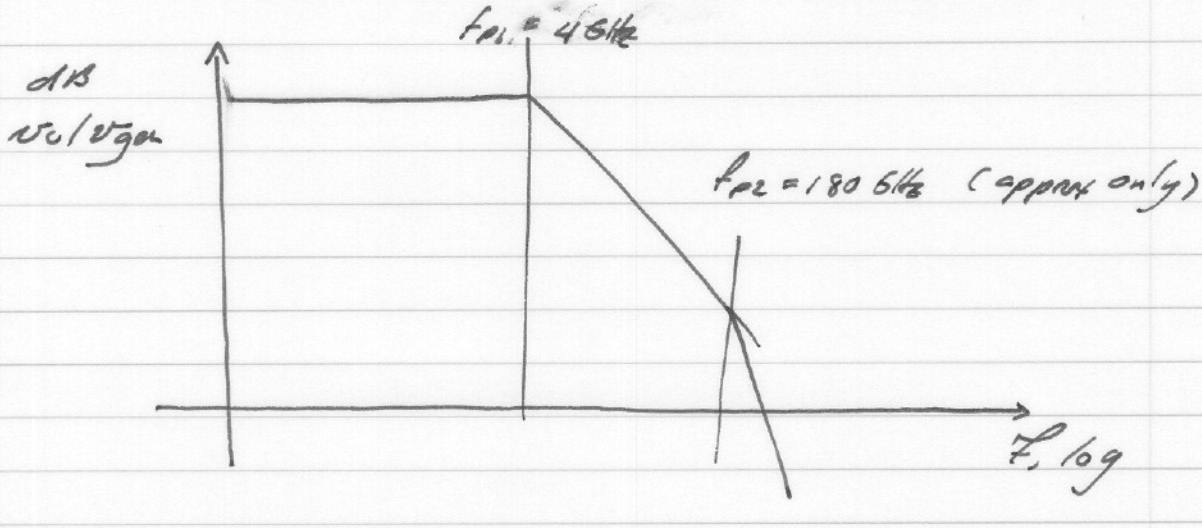
$= 51\ fF \cdot 17.1\ \Omega = 0.87\ ps$

$= 180\ GHz$

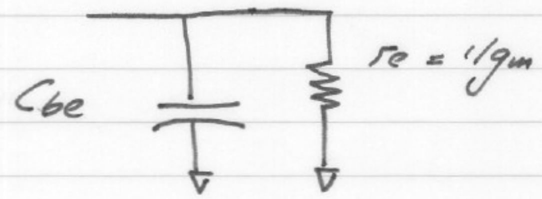
→ higher than f_T ; not realistic.

$f_{output} = 1/2\pi\, \tau_{out}$; $\tau_{out} = R_{Leq}(C_{cs} + C_L)$

$= 4.0\ GHz$ $= 40\ ps$

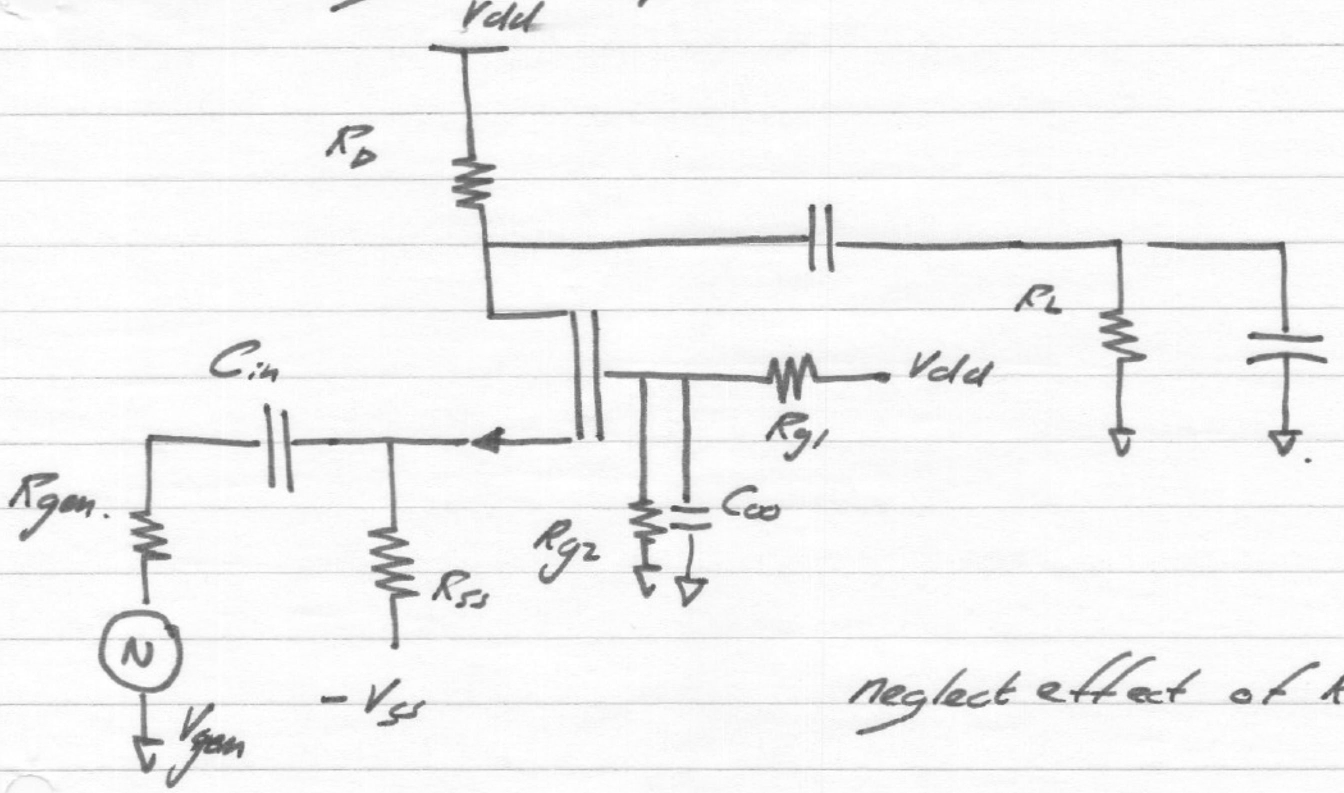


Input impedance of  in common-base

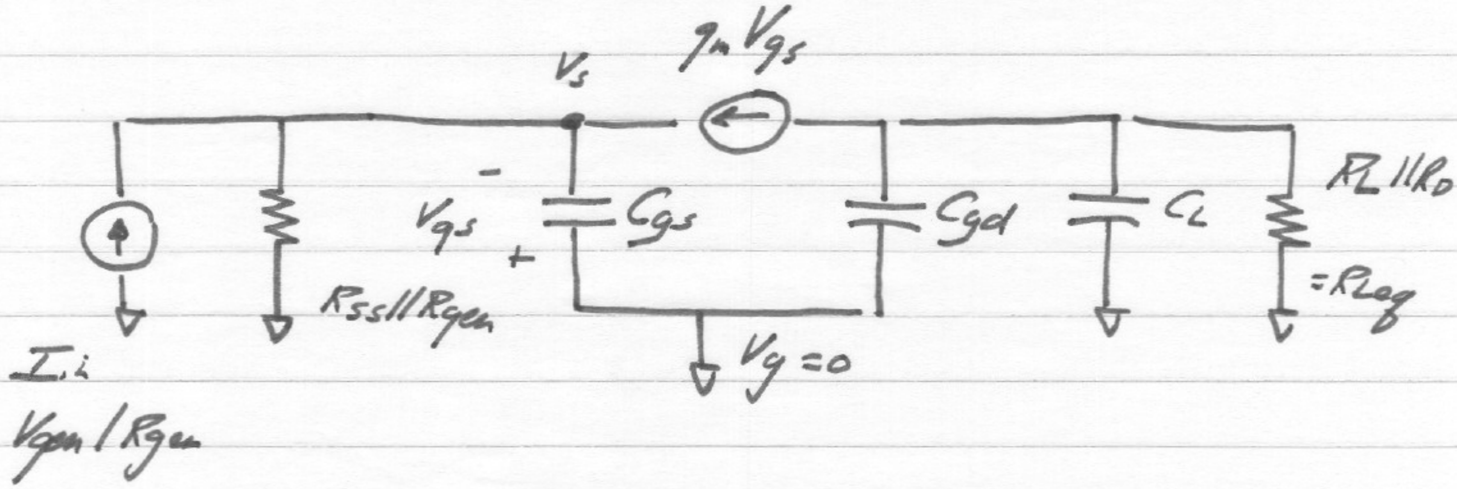


* the impedance (1) changes greatly due to the effect of Rbb. and (2) in 137B we ignore the phase shift of the common-emitter hybrid-π transconductance... this also changes Zin at high frequencies.

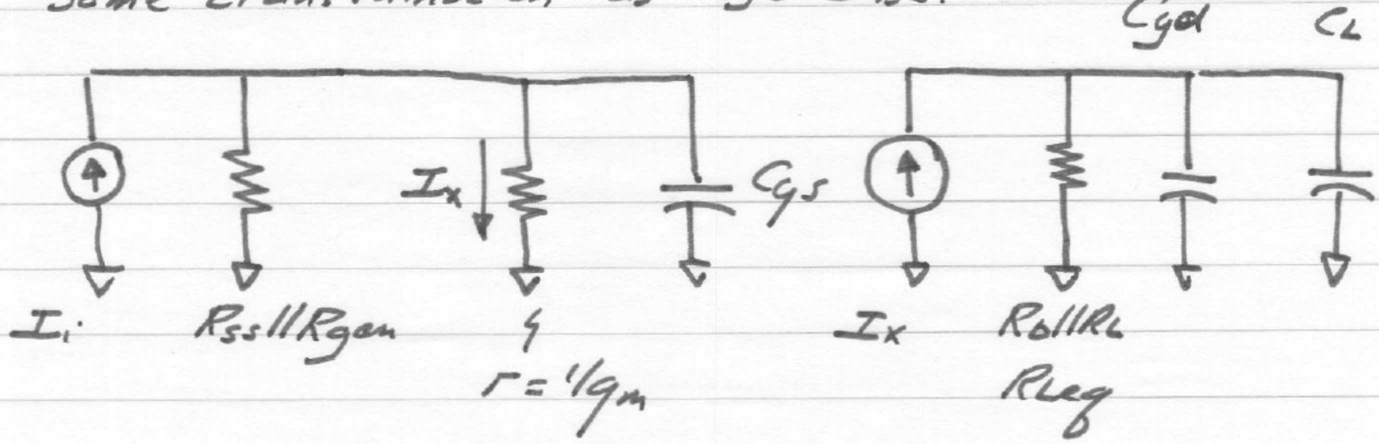
Common-gate amplifier



neglect effect of Rds*



Same transformation as bjt case:



2 poles in transfer function.

one at $f = 1/2\pi\tau_{in}$, where $\tau_{in} = R \cdot C$

$R = (1/g_m) \| R_{SS} \| R_{gen}$

$C = C_{gs}$

one at $f = 1/2\pi\tau_{out}$, where $\tau_{out} = R \cdot C$

$R = R_{Leq}$

$= R_D \| R_L$

$C = C_{gd} + C_L$