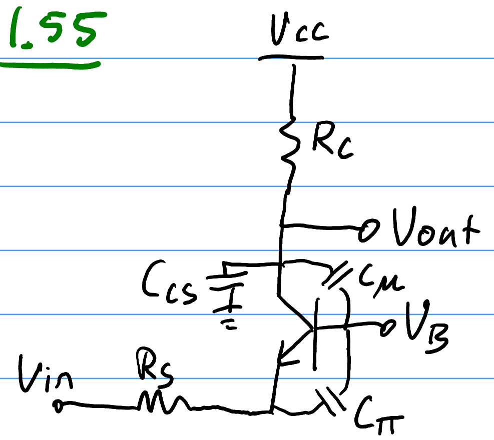
11.55




Design for −3dB bandwidth of 10 GHz, given:

$I_C = 1\ mA$

$V_A = \infty$

$R_S = 50\ \Omega$

$C_\pi = 20\ fF$

$C_\mu = 5\ fF$

$C_{cs} = 20\ fF$

Find max $R_C$ and hence max gain.

Notice: no caps between $V_{in}$ & $V_{out}$

∴ no Miller multiplication.

Consider all independent sources ($V_{in}$, $V_B$, $V_{cc}$) as AC ground.

Input pole: $$f = \frac{1}{2\pi R_S C_\pi} = \frac{1}{2\pi \times 50 \times 20 \times 10^{-15}}$$
$$= 159\ GHz$$

Very fast, no issue.

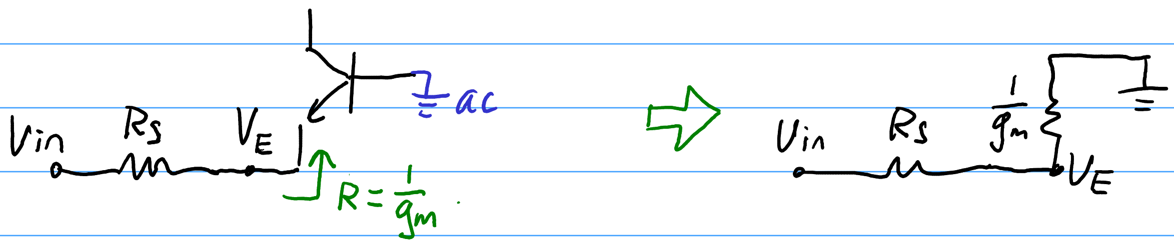
Output pole: $$f = \frac{1}{2\pi R_C (C_{cs} + C_\mu)}$$ caps in parallel.

$$R_C = \frac{1}{2\pi f (C_{cs} + C_\mu)}$$
$$= \frac{1}{2\pi \times 10 \times 10^9 \times (20+5) \times 10^{-15}}$$
$$= 637\ \Omega.$$

To find the max gain, we need to consider the gain equation for this topology.

If $R_S$ were $0$ then the gain of the common base core would be $A_v = g_m R_C$,
where $g_m = \frac{I_C}{V_T} = \frac{1\ mA}{26\ mV} = \frac{1}{26}\ S$.

Consider that $R_S$ forms a voltage divider with the impedance looking into the emitter.




$$\therefore V_E = \frac{1/g_m}{R_S + 1/g_m} \cdot V_{in}$$

Multiply by the gain of the CB amplifier.

$$\frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_E}\frac{V_E}{V_{in}} = g_m R_C \cdot \frac{\frac{1}{g_m}}{R_S + \frac{1}{g_m}}.$$

$$= \frac{R_C}{R_S + \frac{1}{g_m}}$$

$$= \frac{637}{50 + 26}$$

$$= 8.36.$$

← Max gain given bandwidth requirement.