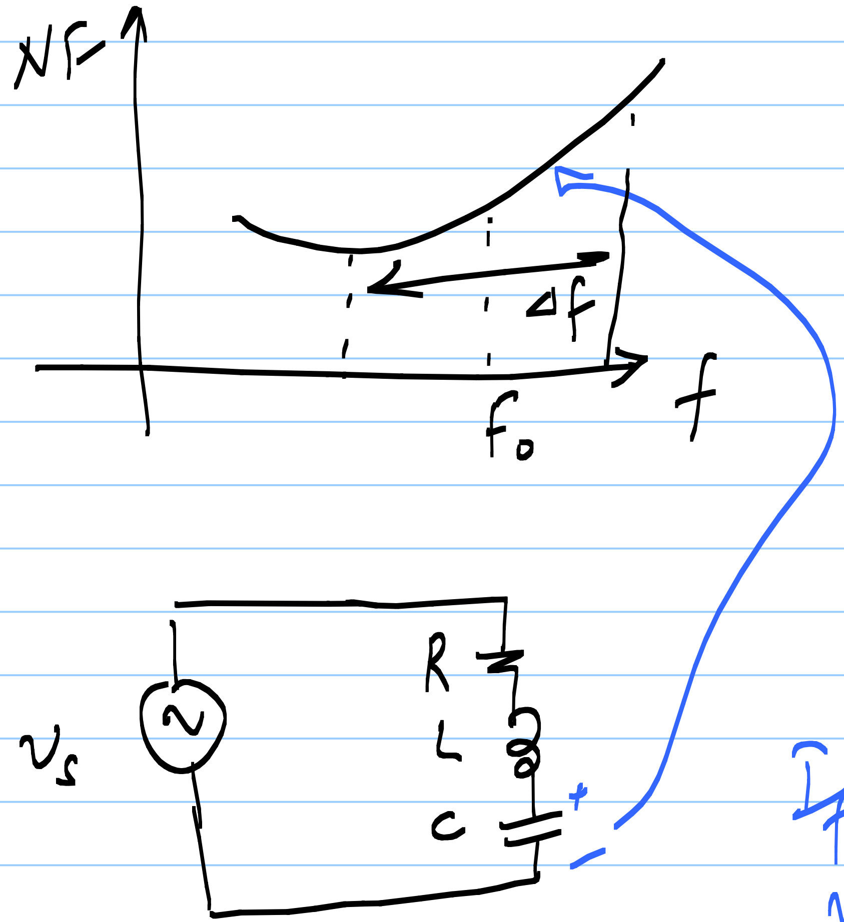
19/2/20

Lec 15



$$Q_{\omega_0} = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 C R}$$

If you go outside band:

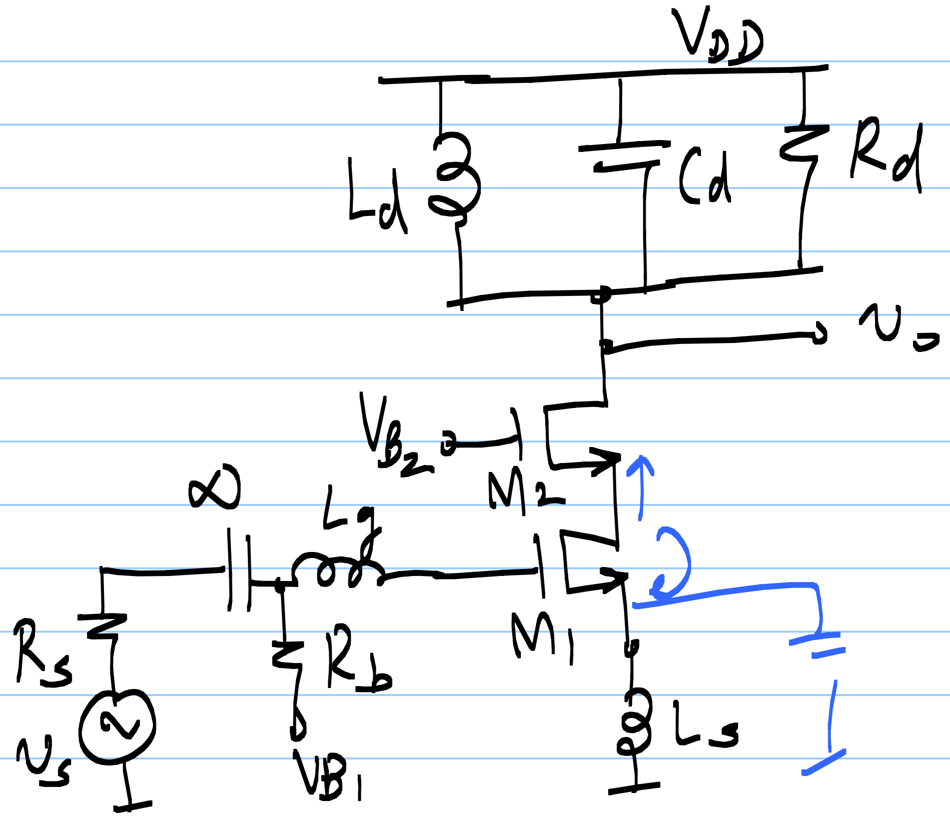
$v_s \downarrow$

effect of R_d noise

Induced gate noise: (See 2011 lectures)

- * depends on δ (empirical parameter)
- * coloured noise
- * ↑ with operating freq.
- * partially correlated with drain thermal noise
- * depends on C_{gs} & r_g
- * $|S_{11}|_{min}$ & F_{min} need not occur at same frequency

LNA Design procedure



@ drain :

$$f_o = \frac{1}{2\pi\sqrt{L_d C_d}}$$

larger Rd

- → larger gain
- → lower NF
- → should meet LNA BW requirements

1) Choose L_d, C_d & R_d to set f_0 and Q_{drain}

$$C_d = C_{par_{M_2}} + C_{Load} + C_{variable}$$

2) Set Q_{in} based on BW requirement

$$Q_{in} = \frac{1}{2\omega_0 C_{gs} R_s}$$

3) Set $L = L_{min}$

Set W based on C_{gs} from (2)

4) $\left(\frac{W}{L}\right)_2 = \left(\frac{W}{L}\right)_1$; $V_{B_2} = V_{DD}$

5) $\omega_T L_s = R_s$

maximise ω_T to minimise NF

$$\omega_T = \frac{g_m}{C_{gs}}$$

- $g_m \propto \sqrt{W}$
- $C_{gs} \propto W$

} minimise W, $L = L_{min}$

- $g_m \propto \sqrt{I} \Rightarrow$ maximise I_{bias}

maximise $(V_{GS} - V_T)$

e.g. $f_T = 300\,\text{GHz}$

$$L_s = \frac{R_s}{2\pi f_T} = 26.5\,\text{pH}$$

L_s of $\sim 100\,\text{pH}$ can be reliable achieved with good accuracy at a few GHz

$\Rightarrow$ choose $f_T \approx 75\,GHz$

6) Choose L_g for $f_0 = \dfrac{1}{2\pi\sqrt{C_{gs}(L_s+L_g)}}$

7) Set I_{bias} = max allowed current