Lec 16

b) $Z_s = sL_s$

$$Z_{in} = sL_s + \frac{1}{sC_s} + \frac{g_m L_s}{C_s}$$

- $g_m L_s / C_s = W T L_s$

Set $f_0$, $I_{bias}$, $W T L_s$ independently

- Add another degree of freedom

1. Add cap $C_x$ in parallel to $C_s$

   $Z_{in}' = \frac{g_m}{G_s + C_x} \times \text{real}(Z_{in})$

2. Add $L_s$ in series with the gate

   $$f_0 = \frac{1}{2\pi \sqrt{C_s (G_s + L_s)}}$$

- Low noise (no physical resistor)
- Small $S_{11} \Rightarrow W T L_s = 50\Omega$

- Make $L_s$ & $C_s$ resonate @ derived freq $f_0$

  Constraint:

  $$\frac{C_s}{G_s} \times I_{bias}$$

III. $C_s$ @ source of c.s.

$$Z_{in} = \frac{1}{sC_s} + \frac{1}{s C_{gs}}$$

$$Z_{in} = \frac{1}{C_s} + \frac{1}{C_s} + \frac{g_m}{s^2 G_s C_s}$$

$\Rightarrow$ -ve resistance

$\Rightarrow$ freq. dependent
\[ Q_{in} = \frac{W(L_g + L_s)}{2R_s} \]

- \( L_d - C_d \) => Swings are better
  - OOB filtering better
  - BW limitation (\( L_s \))

- \( \text{Gain, NF, linearity, BW} \)
- Narrowband LNA
- \( \text{BW dependence on} \quad Q_{in} \quad \text{and input clipping} \)
Gain: \( V_{gs} = \frac{V_{in}}{\alpha} \)

\[ V_{gs} = \frac{V_{in}}{\alpha} \]

\[ i_d = \frac{V_{in}}{R_{in}} \cdot V_s \]

\[ V_{out} = g_m \cdot i_d \cdot V_{in} \cdot V_s \]

Gain: \( \frac{V_{o}}{V_{s}} = g_m \cdot i_d \cdot R_{in} \)

a) More gain than normal C-S-A.
   Dep. on \( R_{in} \)

b) NF better than normal C-S-A.
   Dep. on \( R_{in} \)

c) Linearity worse than normal C-S-A.