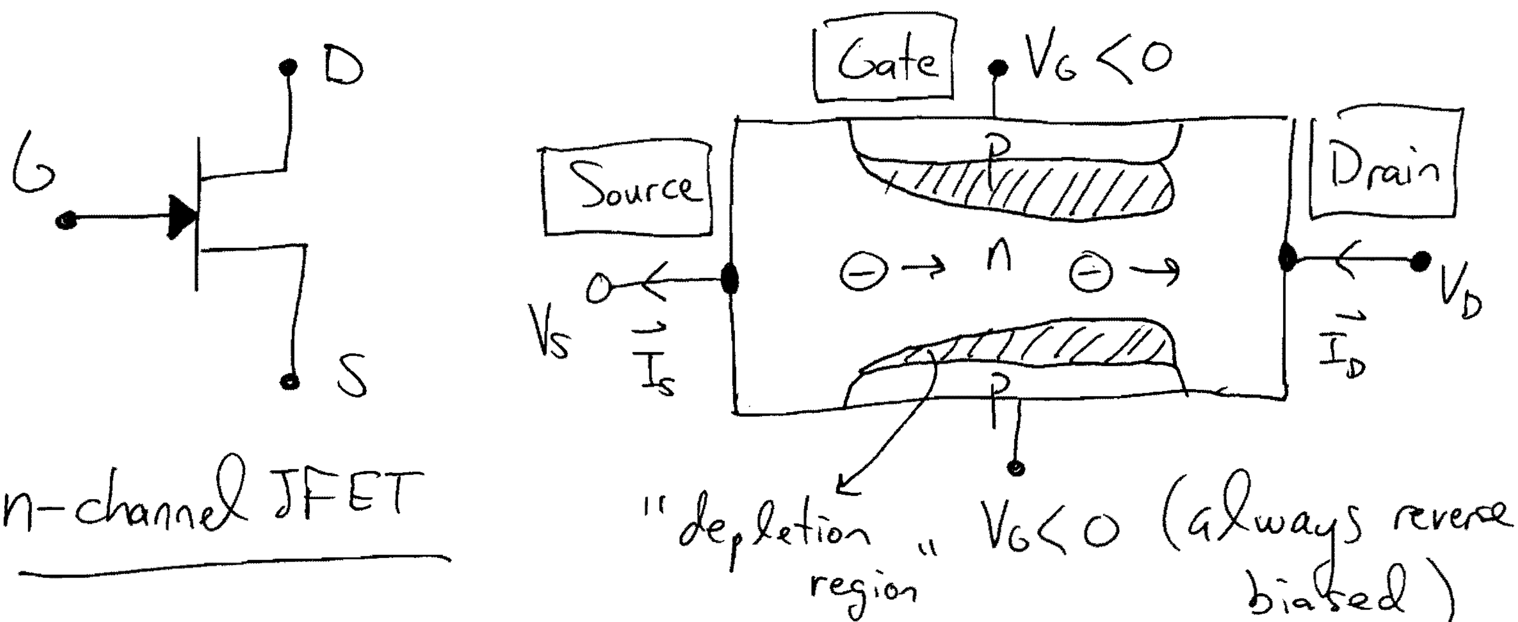
Field-Effect Transistors:

It's hard to overstate the importance of these devices in modern electronics.

JFET: (Junction Field-Effect Transistor)

Primarily n-channel because n-type materials are on average more conductive.

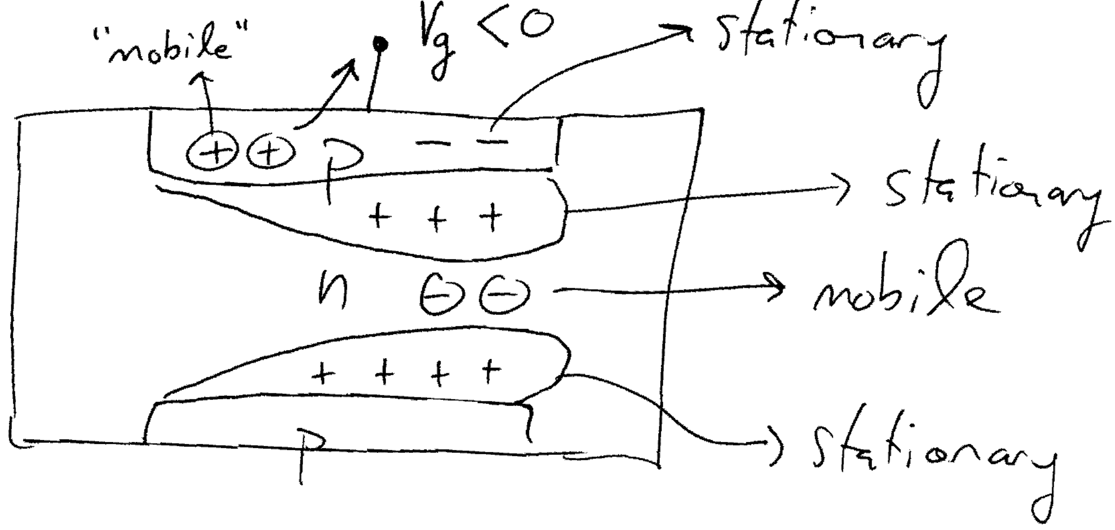


n-channel JFET

V_G is always reverse biased so current flows only in the channel. The shaded depletion region is fixed positive ionic backbone (from n-type material). By making V_G large enough (and negative) we can pinch off the $\vec{I}$.

Depletion region :

n-channel JFET

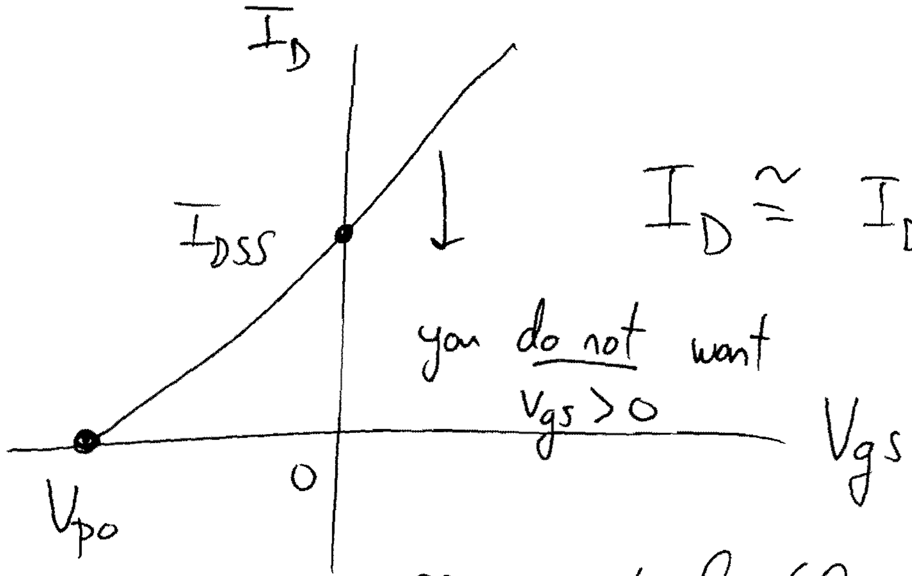


p-type = mobile ⊕ , stationary −

n-type = mobile ⊖ , stationary +

① The negative V_g attracts mobile ⊕ from the p region, leaving behind stationary −.

② These stationary − regions repell mobile ⊖ in the n-type regions, leaving behind stationary +, which is the depletion region. (1A)

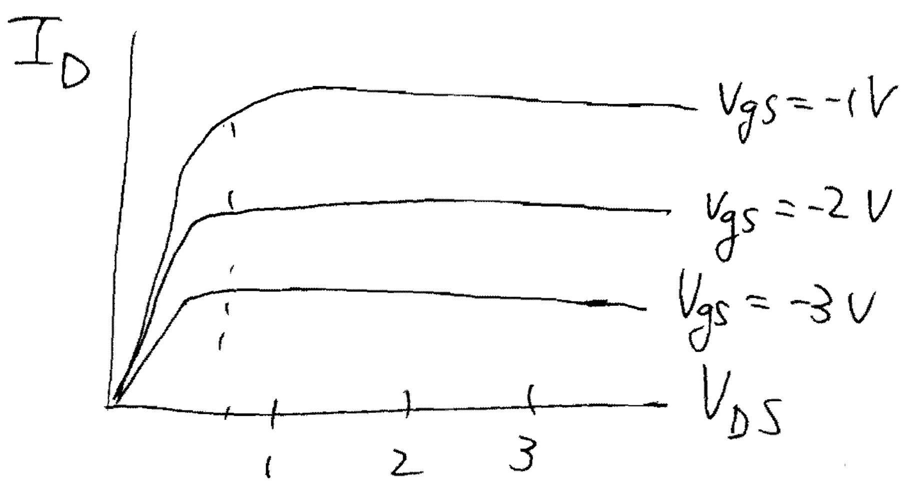


$$I_D \simeq I_{DSS}\left(\left[1-\left(\frac{V_{gs}}{V_{po}}\right)\right]^2\right)$$

↳ Simpson Eq (6.4)

V_{po} ↳ pinch off potential (large depletion region)

I_{DSS} = un-gated channel current flow.



↑ less pinching!

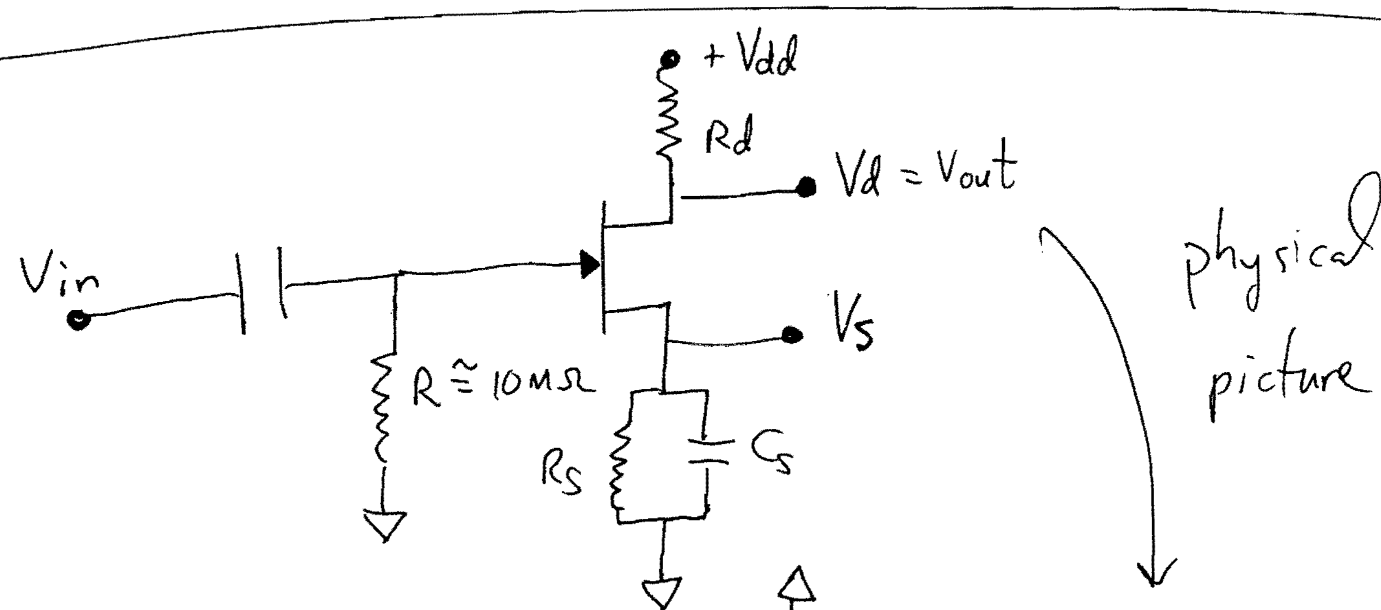
FET transconductance :

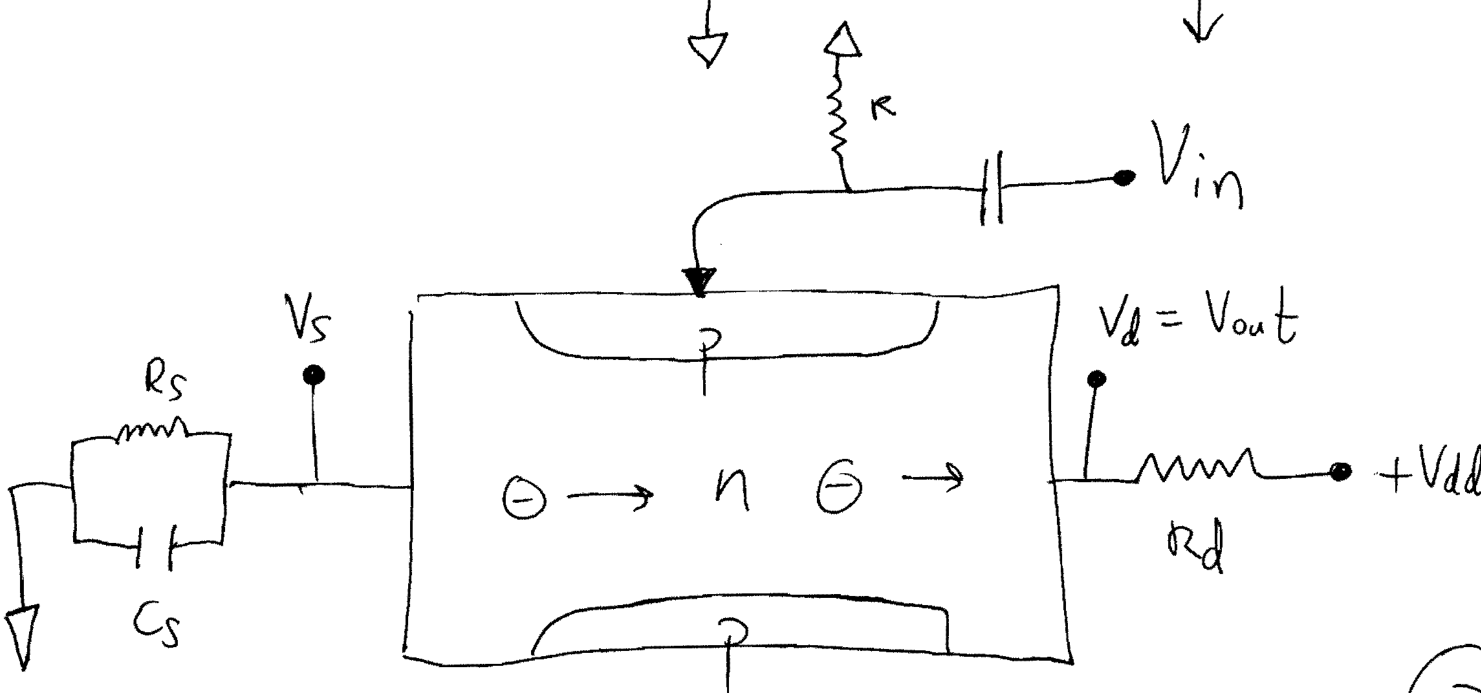
$$Y = \left(\frac{\partial I_D}{\partial V_{gs}}\right)_{V_{DS}}$$

↗ constant drain-source potential

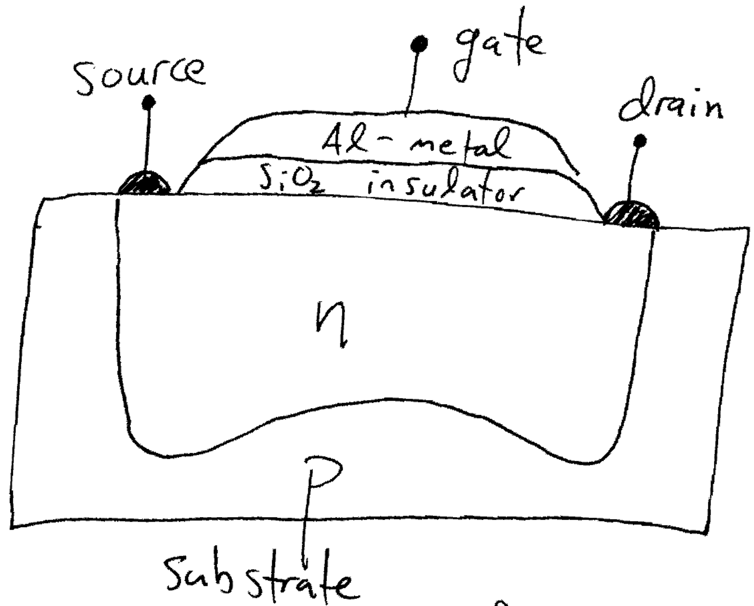
Now that I_D vs. V_{gs} is determined you want to pick the largest trans-conductance (slope) as the V_{gs} DC operating points. (Around $V_{gs} \cong -1V$)

n-channel JFET Common Source Amp.

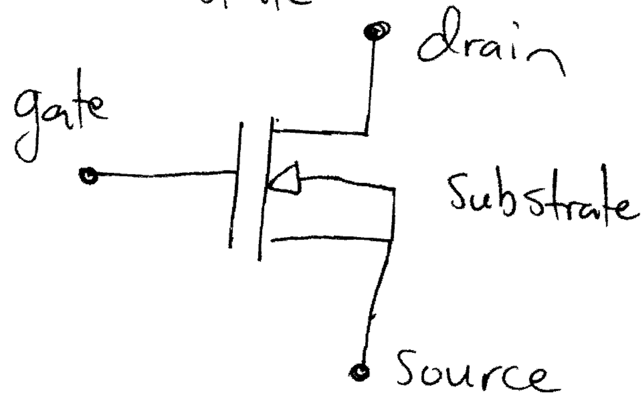




Mosfet : (Metal-oxide-semiconductor FET)

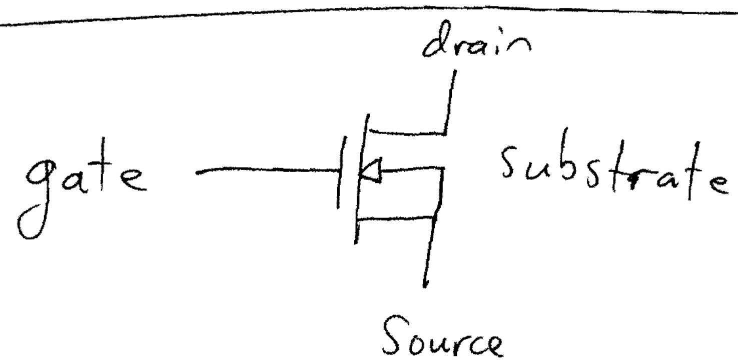


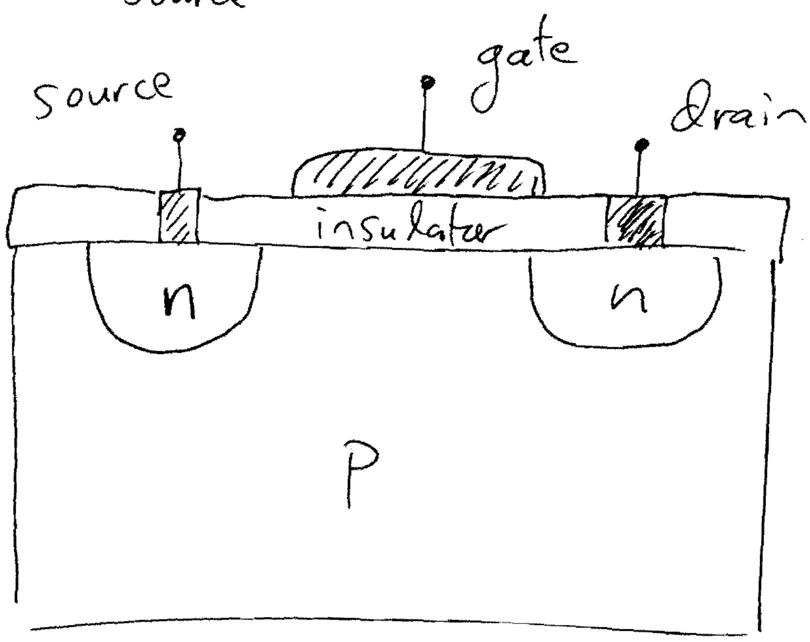
n-channel MOSFET "Depletion Mode"



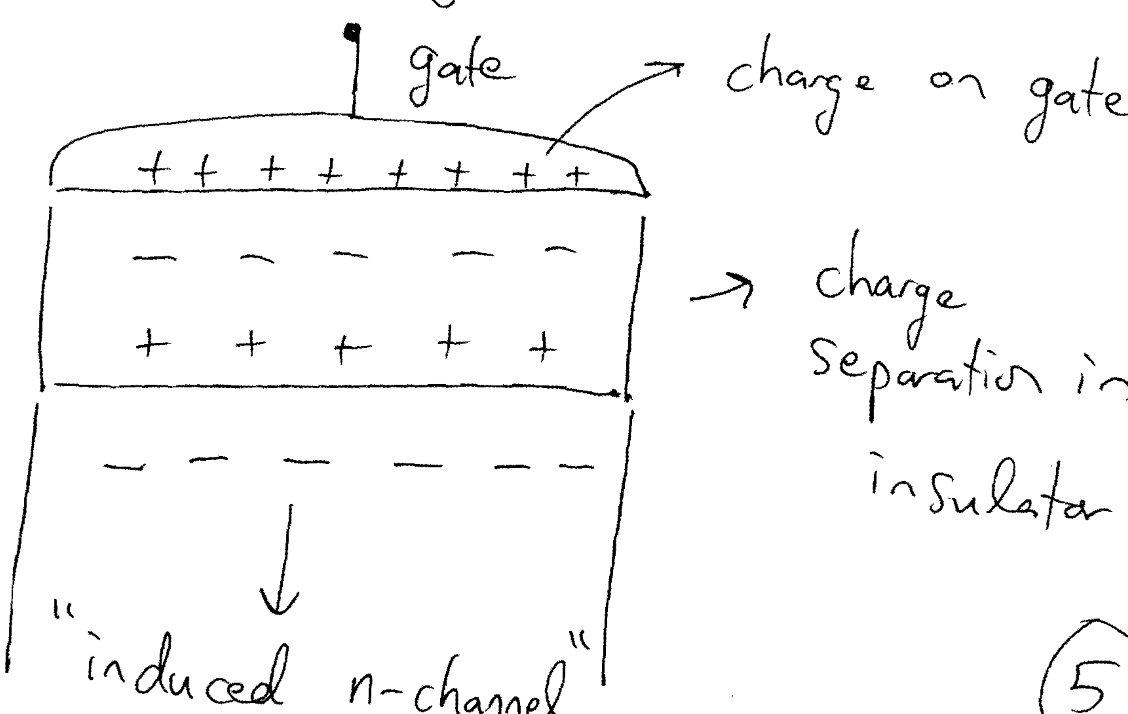
- MOSFET has smaller internal capacitance and hence, so it operates at higher frequencies than JFET.
- The gate in MOSFET is separated from the current channel by a good insulator, causing high gate-channel impedance

n-channel enhancement mode MOSFET :

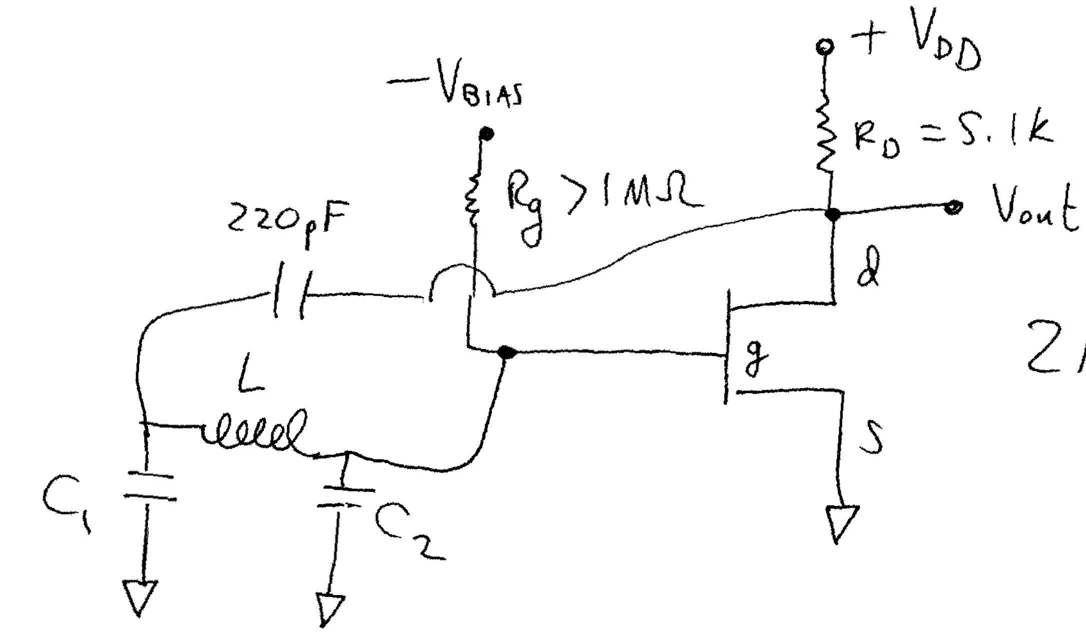




Zoom in on gate :

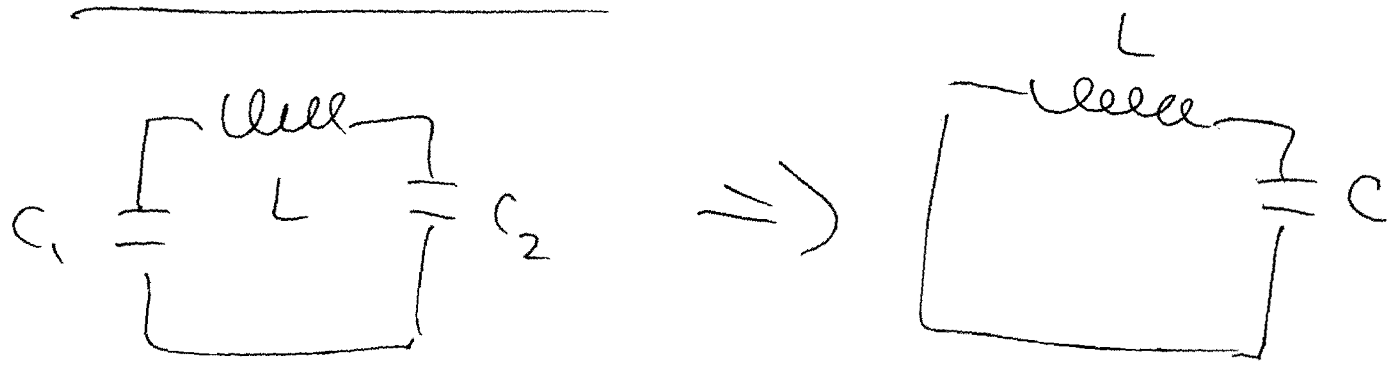


Colpitts Oscillator:



2N5459
JFET

W_0 derivation:



$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \longrightarrow C = \frac{C_1 C_2}{C_1 + C_2}$$

$$\sum \Phi = 0 \Rightarrow \frac{Q}{C} + L\frac{dI}{dt} = 0$$

or $\ddot{Q} = \frac{-Q}{LC}$, $Q(t) = Q_0 e^{i W_0 t}$

$$\boxed{W_0 = \frac{1}{\sqrt{LC}}}$$

(6)