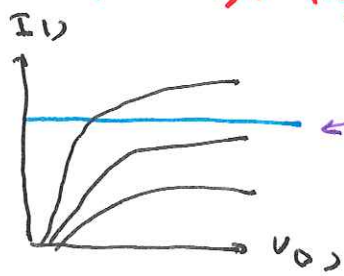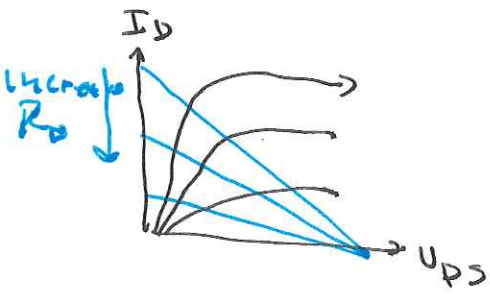# Additional FET circuits.

Note that for comm source amp, if we want for higher gain by increasing R_D the operation point was pushed to closer to V_T with resulting reduction in g.

[Increasing R_D does result in higher gain - just not as much gain increase as might expect]

Warning: this idea of going for increased gain is almost always the wrong approach — eg it increases Z_{out} which is generally bad. We introduce it here mostly as a way of introducing the idea of an "active load" — not because its anything to actually do.
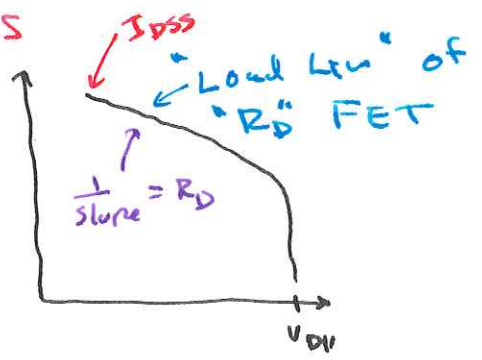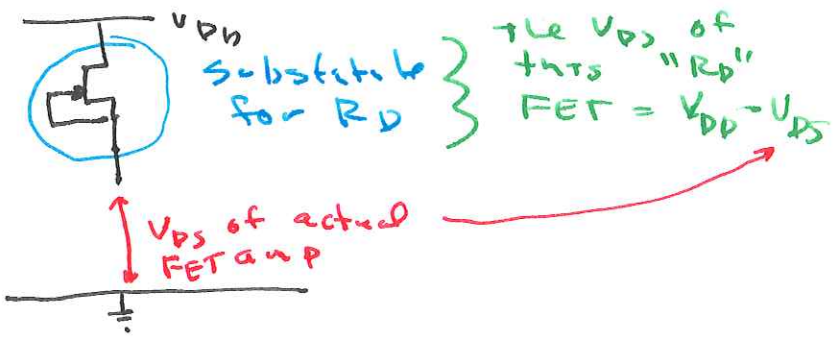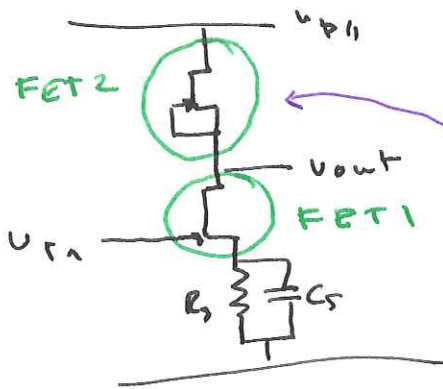

if we had a load line like this very small changes in V_G → big V_{DS} swings ie big gain

a device like this would be called a constant current source.

Remark 1: Since the slope on I vs V is $\frac{1}{R}$, constant current sources correspond to $R = \infty$ [Note $R_D \to \infty$ should give use big gain es $A \approx -g R_D$]

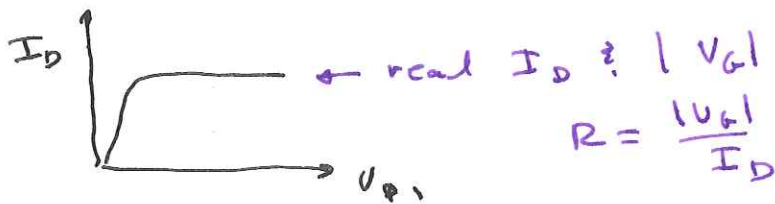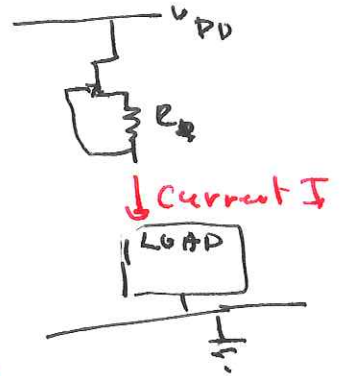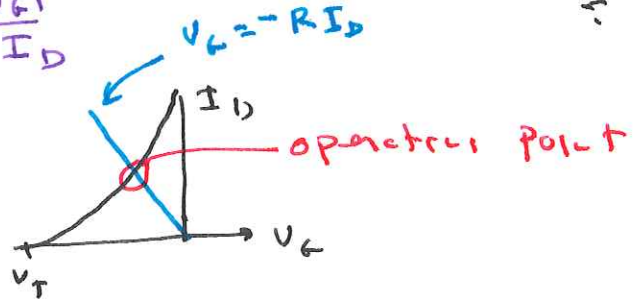Remark 2: (Important) A FET acts a bit like a constant current source — ie those plateaus

Substitute for R_D } The V_{DS} of this "R_D" FET $= V_{DD} - V_{DS}$

V_{DS} of actual FET amp

"Load Line" of "R_D" FET

$\frac{1}{slope} = R_D$

FET2

v_{p11}

v_{out}

FET1

v_{in}

R_s C_s

Repeat warning: $R_D \to \infty$ is a bad idea

"Active Load" — HH talks about improving followers with active load that is a good & useful idea.

Good Idea: FET as a current source — set I via R. [Note: $R \to 0 \Rightarrow I_{DSS}$]

I_D

← real I_D & $|V_G|$

V_{DS}

$R = \dfrac{|V_G|}{I_D}$

v_{PD}

R_s

↓ Current I

LOAD

alt: load line analysis:

$V_G = -R I_D$

I_D

— operating point

V_T V_G

Remark: HH talks about "current limited diodes" — pre built FETs with correct R to produce a specified current. These always sound like a great idea to me, but any time I've thought to use them I've found them ① hard to find (buy e.g. from Digi-Keys) ② pricey — much more than a FET.

Good Idea — FET (in its linear region) as a voltage controlled resistor. The "linear region" is not super linear but HH describe how to improve it.

$$\frac{1}{R_{DS}} = 2k\underbrace{\left[(V_G - V_T) - \frac{V_{DS}}{2} \right]}_{g}$$

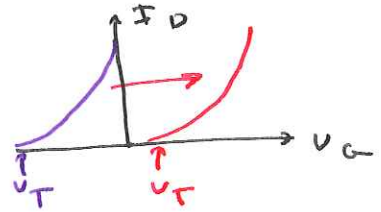Good Idea — use a ON/OFF FET (particulars a MOSFET) as a switch.

On resistance few Ω; OFF: expo small leakage currents. MOSFETS can control multiple As! — Power MOSFETS

packaged "analog switches"

enhancement mode MOSFET

2N7000 : TTL signals control .1 or 1 A

Why use a discrete FET instead of a 411?
→ high input impedance → for followers
  (FET amps don't have much gain & are subject to parameter variation)
→ current source
→ Sometimes a single FET exactly matches need
→ MOSFET current switches / power control
  ↳ recall switching power supplies