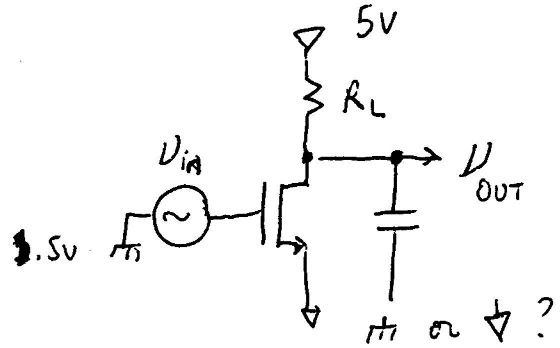

NONLINEAR !

$$\frac{V_{DD} - V_{OUT}}{R_L} = I_Q = f(V_{GS}\ V_{OUT}) \quad DC$$

solve for V_{OUT} — either triode or active eqn.

usually NOT 2.5V, but close
varies with temp.

$$v_{GS} = V_{GS} + v_{in}(t)$$
$$= DC + AC$$

add $v_{in}(t)$ use 1st ORDER TAYLOR expansion, take time varying $v_{in}(t)$, $v_{out}(t)$ out of nonlinear functions, worry about region of validity!

NONLINEAR DIFF. EQU.

$$\frac{V_{DD} - V_{OUT} - v_{out}}{R_L} = f(V_{GS} + v_{in}, V_{OUT} + v_{out}) + C_L \frac{dv_{out}}{dt}$$

$$= I_Q + v_{in}\frac{\partial f}{\partial V_{GS}} + v_{out}\frac{\partial f}{\partial V_{DS}} + C_L \frac{d}{dt} v_{out}$$

$$\frac{V_{DD} - V_{OUT}}{R} - \frac{v_{out}}{R_L} = I_Q + g_m v_{in} + \frac{v_{out}}{r_{DS}} + C_L \dot{v}_{out}$$

DC operating point — zero order equn.

$$\frac{V_{DD} - V_{OUT}}{R_L} = I_Q(V_{GS}, V_{OUT})$$

DON'T FORGET $C_{gs} = \left.\frac{\partial Q}{\partial V_{GS}}\right|_{Q\ \text{POINT}}$

1st ORDER LINEAR EQUN.

$$0 = g_m v_{in} + v_{out}\left(\frac{1}{r_{DS}} + \frac{1}{R_L}\right) + C_L \dot{v}_{OUT}$$

solve both ZERO & FIRST ORDER (sequentially), then combine back for total answer.