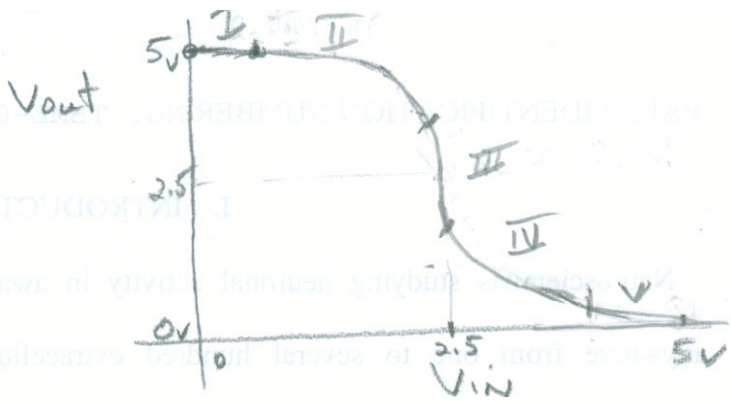


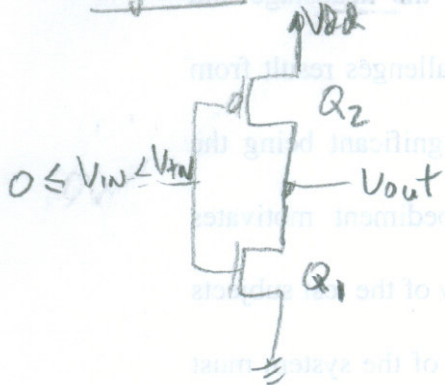
PROB 3

Q_2 is beta match Q_1

$$\frac{W_n}{L_n} = \frac{W_p}{L_p} = 3/1$$



Region I: $0 \leq V_{in} < V_{tn}$



Q_2 is linear
 Q_1 is cutoff

$$I_{dsp} = 0 = I_{dsn}$$

Region	nmos	pmos
I	OFF	LIN
II	SAT	LIN
III	SAT	SAT
IV	LIN	SAT
V	LIN	OFF

Region II: $V_{tn} \leq V_{in}$ and $V_o > V_{in} - 0.8$ and $|V_{osp} - V_o| < |V_{in} - 5| - 0.9V$
 $V_{dsn} > V_{gsn} - V_{tn}$ and $|V_{osp}| < |V_{gspl} - V_{tpl}|$
 $V_o < V_{in} - 0.9V$

Q_2 is LIN
 Q_1 is SAT
 $I_{dsn} = I_{dsp}$

$$I_{dsn} = \frac{1.35 \times 10^{-3}}{2} (V_{in} - 0.8)^2, \quad I_{dsp} = \frac{1.35 \times 10^{-3}}{2} (5 - V_{in} - 0.9 - \frac{5 - V_{out}}{2}) (5 - V_{out})$$

$$I_{dsn} = \frac{1.35 \times 10^{-3}}{2} (V_{in} - 0.8)^2 = \frac{(2.5 - 0.9 - V_{in} - \frac{V_{out}}{2}) (5 - V_{out}) 1.35 \times 10^{-3}}{2}$$

$$I_{dsp} = \frac{1.35 \times 10^{-3}}{2} (1.6 - V_{in} - \frac{V_o}{2}) (5 - V_o)$$

Region III: Q_2 is SAT
 Q_1 is SAT
 $V_{tn} \leq V_{in}$ and $V_o > V_{in} - 0.8$ and $V_o > V_{in} - 0.9V$

$$I_{dsn} = \frac{1.35 \times 10^{-3}}{2} (V_{in} - 0.8)^2$$

$$I_{dsp} = \frac{1.35 \times 10^{-3}}{2} (5 - V_{in} - 0.9)^2 = \frac{1.35 \times 10^{-3}}{2} (4.2 - V_{in})^2$$