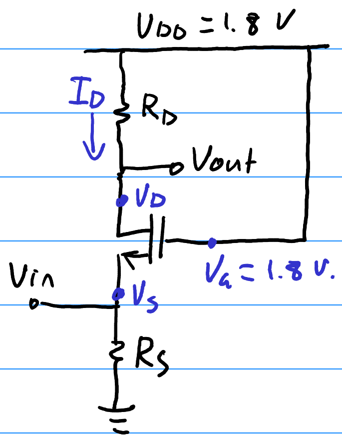
7.68



Design CB amplifier for $A_v = 4$, power budget of 2 mW, and to operate 100 mV away from the triode region.

$$I_D = \frac{P}{V_{DD}} = \frac{0.002}{1.8} = 1.111\ mA.$$

Analyse the bias point.

V_{DS} is 0.1 V away from triode

$$\therefore V_{DS} = V_{GS} - V_{TH} + 0.1 = V_{GS} - 0.3$$

$$V_{GS} = V_G - V_S = 1.8 - I_D R_S = 1.8 - (1.111 \times 10^{-3}) R_S.$$

$$\therefore V_{DS} = 1.8 - (1.111 \times 10^{-3}) R_S - 0.3$$
$$= 1.5 - (1.111 \times 10^{-3}) R_S.$$

By KCL, $V_{DD} = I_D R_D + V_{DS} + I_D R_S$

$$1.8 = (1.111 \times 10^{-3})(R_D + R_S) + 1.5 - (1.111 \times 10^{-3}) R_S$$
$$0.3 = (1.111 \times 10^{-3}) R_D$$
$$R_D = 270\ \Omega.$$

Analyse the required transconductance. $A_v = g_m R_D$

$$\therefore g_m = \frac{A_v}{R_D} = \frac{4}{270} = 14.82\ mS.$$

This will require a certain V_{GS}.

$$g_m = \frac{2 I_D}{V_{GS} - V_{TH}} = 14.82 \times 10^{-3} = \frac{2 \times 1.111 \times 10^{-3}}{V_{GS} - 0.4}$$

$$\therefore V_{GS} = 0.55\ V.$$

In turn, this requires a certain R_S.

$$V_{GS} = V_G - V_S = 1.8 - I_D R_S$$
$$0.55 = 1.8 - (1.111 \times 10^{-3}) R_S$$
$$R_S = 1.125\ k\Omega.$$

Find the required $\frac{W}{L}$ from the transistor characteristic:

$$I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2$$
$$\frac{W}{L} = 494.$$