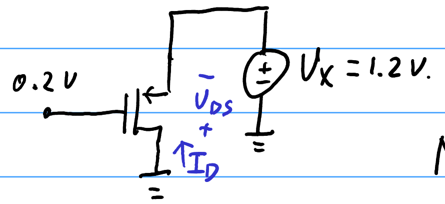
7.15



$\frac{W}{L} = \frac{10}{0.25}$, $\lambda = 0.1\ V^{-1}$

Notice: PMOS type! $\mu_p C_{ox} = 100 \times 10^{-6}\ \frac{A}{V^2}$

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

$V_{GS} = 0.2 - 1.2 = -1$ V.

$V_{DS} = -1.2$ V.

$$\therefore\ I_D = \frac{-1}{2} \times 100 \times 10^{-6} \times \frac{10}{0.25} \times (-1 - (-0.4))^2 (1 - 0.1 \times (-1.2))$$

$= -0.806$ mA.

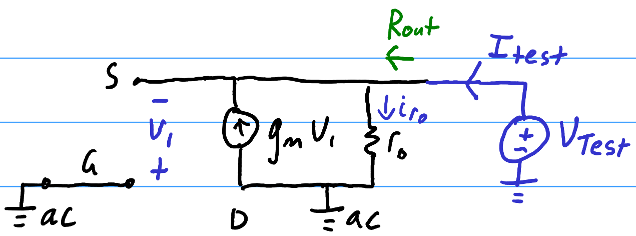
In case we aren't sure about g_m for PMOS, start from first principles. $g_m = \frac{\partial I_D}{\partial V_{GS}}$. Include λ this time.

$$g_m = \frac{\partial I_D}{\partial V_{GS}} = -\mu_p C_{ox} \frac{W}{L} (V_{GS} - V_{TH})(1 - \lambda V_{DS})$$

$$= -100 \times 10^{-6} \times \frac{10}{0.25} \times (-1 - (-0.4))(1 - 0.1 \times (-1.2))$$

$= 2.69$ mS.

Consider the small signal model. $r_o = \frac{1}{\lambda I_D} = 12.41\ k\Omega$.



Notice $V_1 = -V_{Test}$.

By KCL at the source: $g_m V_1 + I_{test} = \frac{V_{test}}{r_o}$

$$-g_m V_{test} + I_{test} = \frac{V_{test}}{r_o}$$

$$I_{test} = \left(\frac{1}{r_o} + g_m\right) V_{test}$$

$$\therefore\ \frac{V_{test}}{I_{test}} = \frac{1}{\frac{1}{r_o} + g_m}.$$

Subst. known values.

$$\frac{V_{Test}}{I_{test}} = R_{out} = 360.9\ \Omega.$$