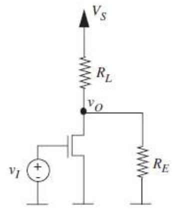
Homework 7

Wednesday, May 17, 2017 11:26 AM

Pr 7.14)



$$V_{GS} = V_I \qquad V_{DS} = V_D = V_o$$

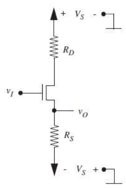
$$I_{ds} = \frac{I_{dss}}{V_{GS(off)}^2}\left(V_{GS} - V_T\right)^2 \qquad \frac{2I_{dss}}{V_{GS(off)}^2} \equiv K$$

$$I_{ds} + \frac{V_o}{R_E} = \frac{V_s - V_o}{R_L}$$

$$\frac{K}{2}(V_I - V_T)^2 = \frac{V_s - V_o}{R_L} - \frac{V_o}{R_E} = \frac{V_s}{R_L} - \left(\frac{R_E + R_L}{R_E R_L}\right)V_o$$

$$\boxed{V_o = \frac{R_E R_L}{R_E + R_L}\left(\frac{V_s}{R_L} - \frac{K}{2}(V_I - V_T)^2\right)}$$

Pr 7.15)



$$V_s = i_D R_D + V_{Fet} + i_D R_s - V_s$$

$$2V_s - i_D(R_s + R_d) = V_{Fet}$$

$$i_D = \frac{K}{2}\left(V_{GS} - V_T\right)^2 \qquad V_{GS} = V_G - V_o = V_I - V_o \qquad V_o = i_D R_s - V_s$$

$$= \frac{K}{2}\left(V_I - i_D R_s + V_s - V_T\right)^2$$

$$\frac{KR_s^2}{2} i_D^2 - \left(1 + KR_s(V_I + V_s - V_T)\right) i_D + \frac{K}{2}(V_I + V_s - V_T)^2 = 0$$

$$i_D = \frac{1}{KR_s^2}\left(KR_s(V_I + V_s - V_T) + 1 \pm \sqrt{(1 + KR_s(V_I + V_s - V_T))^2 - K^2R_s^2(V_I + V_s - V_T)^2}\right)$$

$$= \frac{1}{R_s}(V_I + V_s - V_T) + \frac{1}{KR_s^2} \pm \frac{1}{KR_s^2}\sqrt{2KR_s(V_I + V_s - V_T) + 1}$$

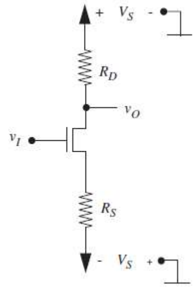
$$= \frac{1}{R_s}(V_I + V_s - V_T) + \frac{1}{KR_s^2} - \sqrt{\frac{2}{KR_s^3}(V_I + V_s - V_T) + \frac{1}{K^2 R_s^4}}$$

$$V_o = i_D R_s - V_s$$

$$= \boxed{V_I - V_T + \frac{1}{KR_s} - \sqrt{\frac{2}{KR_s}(V_I + V_s - V_T) + \frac{1}{K^2 R_s^2}}}$$

$$\boxed{V_o(V_I = 0) = -V_T + \frac{1}{KR_s} - \sqrt{\frac{2}{KR_s}(V_s - V_T) + \frac{1}{K^2 R_s^2}}}$$

Pr 7.16)



set-up is exactly the same as above, just moving V_o

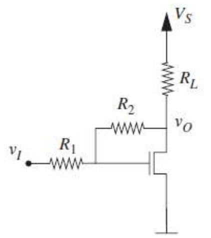
$$V_o = V_s - i_{DS} R_D$$

$$i_{DS} = \frac{1}{R_s}(V_I + V_s - V_T) + \frac{1}{KR_s^2} - \sqrt{\frac{2}{KR_s^3}(V_I + V_s - V_T) + \frac{1}{K^2 R_s^4}}$$

$$\boxed{V_o = V_s\left(1 - \frac{R_D}{R_s}\right) - \frac{R_D}{R_s}(V_I - V_T) - \frac{R_D}{KR_s^2} + R_D\sqrt{\frac{2}{KR_s^3}(V_I + V_s - V_T) + \frac{1}{K^2 R_s^4}}}$$

$$\boxed{V_o(V_I = 0) = V_s\left(1 - \frac{R_D}{R_s}\right) + \frac{R_D}{R_s}V_T - \frac{R_D}{KR_s^2} + R_D\sqrt{\frac{2}{KR_s^3}(V_s - V_T) + \frac{1}{K^2 R_s^4}}}$$

Pr 7.17)



$$i_{DS} = \frac{K}{2}(V_{GS} - V_T)^2$$

$$V_{GS} = V_G = \frac{R_2}{R_1+R_2}(V_I - V_o) + V_o$$

$$i_{DS} = \frac{V_S - V_o}{R_L} + \frac{V_I - V_o}{R_1+R_2}$$

define $R_T = R_1 + R_2$

$$V_{GS} = \frac{R_2}{R_T}V_I + \frac{R_1}{R_T}V_o$$

$$i_{DS} = \frac{V_S - V_o}{R_L} + \frac{V_I - V_o}{R_T} = \frac{K}{2}\left(\frac{R_2}{R_T}V_I + \frac{R_1}{R_T}V_o - V_T\right)^2$$

$$\frac{V_S}{R_L} + \frac{V_I}{R_T} - \frac{R_L+R_T}{R_L R_T}V_o = \frac{K}{2}\left(\frac{R_1}{R_T}\right)^2 V_o^2 + \frac{KR_1}{R_T}V_o\left(\frac{R_2}{R_T}V_I - V_T\right) + \frac{K}{2}\left(\frac{R_2}{R_T}V_I - V_T\right)^2$$

$$\boxed{0 = \frac{K}{2}\left(\frac{R_1}{R_T}\right)^2 V_o^2 + \left[\frac{KR_1}{R_T}\left(\frac{R_2}{R_T}V_I - V_T\right) + \frac{R_L+R_T}{R_L R_T}\right]V_o + \frac{K}{2}\left(\frac{R_2}{R_T}V_I - V_T\right)^2 - \frac{V_S}{R_L} - \frac{V_I}{R_T}}$$