Ex: 5.34

$$R_D = \frac{V_{DD} - V_D}{I_D} = \frac{5 - 2}{0.5} = 6\ \text{k}\Omega$$

$$\rightarrow R_D = 6.2\ \text{k}\Omega$$

$$I_D = \frac{1}{2}k_n'\frac{W}{L}V_{OV}^2 \Rightarrow 0.5 = \frac{1}{2} \times 1 \times V_{OV}^2$$

$$\Rightarrow V_{OV} = 1\ \text{V}$$

$$\Rightarrow V_{GS} = V_{OV} + V_t = 1 + 1 = 2\ \text{V}$$

$$\Rightarrow V_S = -2\ \text{V}$$

$$R_S = \frac{V_S - V_{SS}}{I_D} = \frac{-2 - (-5)}{0.5} = 6\ \text{k}\Omega$$

$$\rightarrow R_S = 6.2\ \text{k}\Omega$$

If we choose $R_D = R_S = 6.2\ \text{k}\Omega$ then I_D will slightly change:

$I_D = \frac{1}{2} \times 1 \times (V_{GS} - 1)^2$. Also

$$V_{GS} = -V_S = 5 - R_S I_D$$

$$2I_D = (4 - 6.2I_D)^2$$

$$\Rightarrow 38.44I_D^2 - 51.6I_D^2 + 16 = 0$$

$$\Rightarrow I_D = 0.49\ \text{mA}, 0.86\ \text{mA}$$

$I_D = 0.86$ results in $V_S > 0$ or $V_S > V_G$ which is not acceptable, therefore $I_D = 0.49$ mA

$V_S = -5 + 6.2 \times 0.49 = -1.96$ V

$V_D = 5 - 6.2 \times 0.49 = +1.96$ V

R_G should be selected in the range of 1 MΩ to 10 MΩ to have low current.

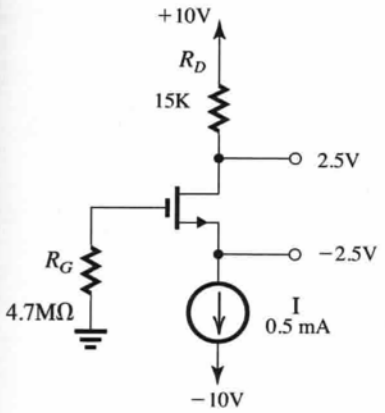
Ex: 5.37

$V_t = 1,5\ \text{V}$

$k_n' \frac{W}{L} = 1\ \text{mA}/\text{V}^2$

$V_A = 75\text{V}.$

$I_D = 0.5\text{mA} = \frac{1}{2} k_n' \frac{W}{L} V_{OV}^2 \Rightarrow \text{V}_{\text{OV}} = 1.0\ \text{V}.$



$V_{GS} = V_t + \text{V}_{\text{OV}} = 2.5\ \text{V}$

$V_G = 0$

$V_S = -2.5\ \text{V}.$

$V_D = V_{DD} - I_D R_D = +2.5\ \text{V}.$

$g_m = k_n' \frac{W}{L} \text{V}_{\text{OV}} = 1\ \text{mA}/\text{V}$

$r_O = \frac{V_A}{I_D} = 150\ \text{k}\Omega$

$V_{GD} - \hat{v}_{gd} = V_t$

$-\hat{v}_{gd} \cong \hat{v}_d = V_t - V_{GD} = 4.0\ \text{V}.$