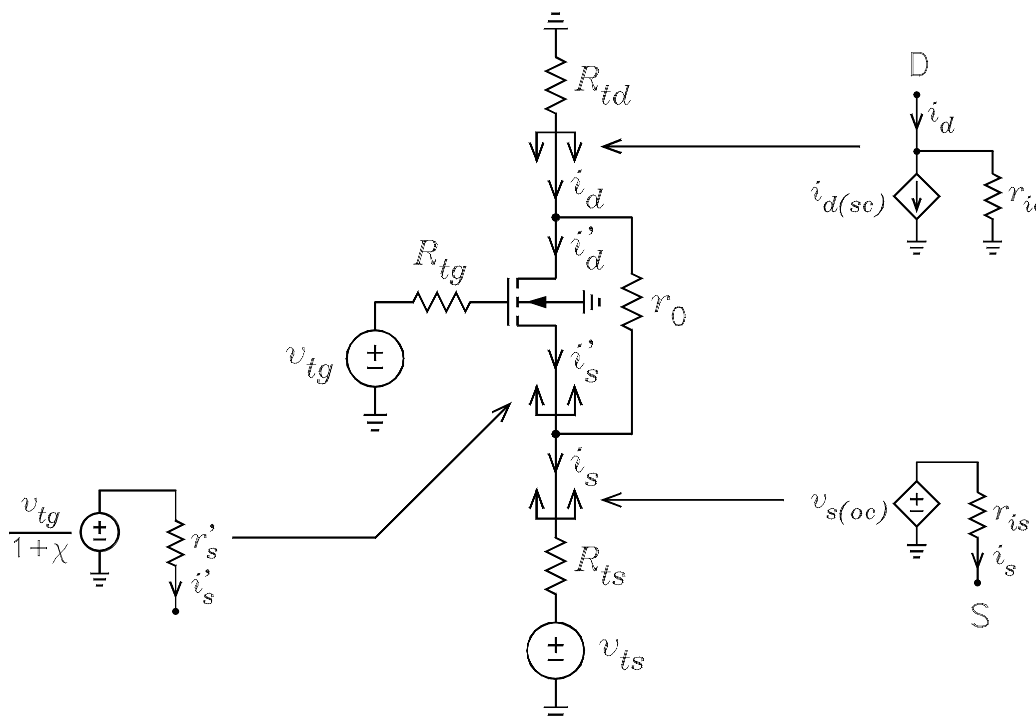
ECE 3050 Analog Electronics –MOSFET and JFET Formula Summary

Equations are for the n-channel MOSFET. For the p-channel device, reverse the directions of all current labels and reverse the order of subscripts involving node labels, i.e. V_{DS} becomes V_{SD}. If the body is connected to the source, set $v_{TH} = V_{TO}$ and $\chi = 0$. For the JFET equations, omit the body lead, set $\chi = 0$, $v_{TH} = V_{TO}$, and replace K with β, where $\beta = \beta_0 (1 + \lambda v_{DS})$.



$$i_D = K (v_{GS} - v_{TH})^2 = I_{DSS}\left(1 - \frac{v_{GS}}{v_{TH}}\right)^2 \qquad v_{TH} = V_{TO} + \gamma\left(\sqrt{\phi - v_{BS}} - \sqrt{\phi}\right)$$

$$I_{DSS} = K V_{TO}^2 \qquad i_S = i_D \qquad i_G = 0 \qquad K = K_0 (1 + \lambda v_{DS}) \qquad K_0 = \frac{k'}{2}\frac{W}{L} \qquad k' = \mu C_{ox}$$

$$v_{DS} \geq v_{GS} - v_{TH} \qquad i'_d = i'_s = g_m v_{gs} + g_{mb} v_{bs} \qquad g_m = 2\sqrt{K I_D} = \frac{-2}{V_{TO}}\sqrt{I_D I_{DSS}}$$

$$g_{mb} = \chi g_m \qquad \chi = \frac{\gamma}{2\sqrt{\phi - V_{BS}}} \qquad r_0 = \frac{\lambda^{-1} + V_{DS}}{I_D} \qquad r_s = \frac{1}{g_m} \qquad r'_s = \frac{r_s}{1+\chi}$$

$$i_{d(sc)} = G_{mg} v_{tg} - G_{ms} v_{ts} \qquad G_{mg} = \frac{1}{1+\chi}\,\frac{1}{r'_s + R_{ts} \| r_0}\,\frac{r_0}{r_0 + R_{ts}} \qquad G_{ms} = \frac{1}{R_{ts} + r'_s \| r_0}$$

$$r_{id} = r_0\left(1 + \frac{R_{ts}}{r'_s}\right) + R_{ts} \qquad v_{s(oc)} = \frac{v_{tg}}{1+\chi}\,\frac{r_0}{r'_s + r_0} \qquad r_{is} = r'_s \frac{r_0 + R_{td}}{r'_s + r_0}$$

r_0 **Approximations** – Assume $r_0 = \infty$ except when calculating r_{id}

$$i_s = i'_s \qquad i_{d(sc)} = i'_d = i'_s = G_{mg} v_{tg} - G_{ms} v_{ts} \qquad G_{mg} = \frac{1}{1+\chi}\,\frac{1}{r'_s + R_{ts}} \qquad G_{ms} = \frac{1}{r'_s + R_{ts}}$$

$$r_s = \frac{1}{g_m} \qquad r'_s = \frac{r_s}{1+\chi} \qquad r_{id} = r_0\left(1 + \frac{R_{ts}}{r'_s}\right) + R_{ts} \qquad v_{s(oc)} = \frac{v_{tg}}{1+\chi} \qquad r_{is} = r'_s$$