Simulation Exercise: NMOS characteristics

1. Download the model file for NMOS transistor(from CD4007 model file) from the "Downloads" .
2. Write ngspice netlist to plot I_D/V_{DS} characteristics for the same with the voltage V_{GS} varied from 2.5 V to 4 V in steps of 0.5 V. You may vary V_{DS} from 0 V to 5 V.

   Show all the 4 curves on a single plot using following command.

   .dc VDS 0 5 0.01 VGS 2.5 4 0.5

   First voltage sweep (VDS) is for X-axis and second voltage sweep (VGS) is for different sets.

   (a) From these characteristics, obtain r_{DS} (linear region) for each value of V_{GS}.
   (b) "Early voltage" and r_0 in saturation region.
3. Estimate the value of threshold voltage and transconductance g_m in linear region:
   (a) Bias the transistor in linear region by keeping $V_{DS} = 200$ mV.
   (b) Now write ngspice netlist to plot $I_D/\ V_{GS}$ characteristics by varying V_{GS} from 0 to 5 V.
   (c) From this characteristic, obtain V_t and g_m.
4. Estimate the value of threshold voltage in saturation region:
   (a) Bias the transistor in saturation region by keeping $V_{DS} = 5$V.
   (b) Now write ngspice netlist to plot $I_D/\ V_{GS}$ characteristics by varying V_{GS} from 0 to 5 V.
   (c) Plot $\sqrt{I_D}$ v/s V_{GS} and obtain V_t.