1) Ideal N-Channel MOSFET IV Characteristics:
(4 Point Each)

For the following N-Channel, enhancement-type MOSFET.

\[
\begin{align*}
V_{T0} &= 0.37 \text{ v} \\
k' &= 178 \ \mu\text{A/V}^2 \ (\text{notice the } \mu\text{A and the } \ ') \\
W &= 2.5 \ \mu\text{m} \\
L &= 0.25 \ \mu\text{m} \\
\lambda &= 0.05
\end{align*}
\]

a) Find \( I_{DS} \) if:

\[
\begin{align*}
V_G &= 1.0 \text{v} \\
V_S &= 0 \text{v} \\
V_D &= 0.3 \text{v} \\
V_B &= 0 \text{v}
\end{align*}
\]

b) Find \( I_{DS} \) if:

\[
\begin{align*}
V_G &= 1.0 \text{v} \\
V_S &= 0 \text{v} \\
V_D &= 2.0 \text{v} \\
V_B &= 0 \text{v}
\end{align*}
\]

c) Find \( I_{DS} \) if:

\[
\begin{align*}
V_G &= 1.5 \text{v} \\
V_S &= 0 \text{v} \\
V_D &= 0.3 \text{v} \\
V_B &= 0 \text{v}
\end{align*}
\]

d) Find \( I_{DS} \) if:

\[
\begin{align*}
V_G &= 1.5 \text{v} \\
V_S &= 0 \text{v} \\
V_D &= 2.0 \text{v} \\
V_B &= 0 \text{v}
\end{align*}
\]

e) Run a DC simulation using S-Edit & T-SPICE using the Generic 0.25um Level 1 model to verify your calculations in parts 1.a-1.d. The parameters for your hand calculations above were taken from the SPICE model so the simulations should match your solutions. You are to produce a single IV plot that indicates the solutions for all 4 of your calculations (i.e., Vds vs. Ids). This can be done by sweeping VDS from 0v-2.5v in linear steps of 0.1v while sweeping VGS from 1v-1.5v in a linear step of 0.5v. Indicate clearly on your plot the current from parts a-d. Also turn in a print of your final S-edit schematic.
2) N-Channel MOSFET IV Characteristics with Body Effect (3 Points)

Now consider how a voltage on the body of the transistor effects $I_{DS}$:

\[
\gamma = 0.029 \, V^{1/2} \\
2 |\phi_b| = 0.279 \, V
\]

a) Find $I_{DS}$ if:

- $V_G = 1.0 \, v$
- $V_S = 0 \, v$
- $V_D = 0.3 \, v$
- $V_B = 0.5 \, v$

b) Find $I_{DS}$ if:

- $V_G = 1.0 \, v$
- $V_S = 0 \, v$
- $V_D = 2.0 \, v$
- $V_B = 0.5 \, v$

c) Find $I_{DS}$ if:

- $V_G = 1.5 \, v$
- $V_S = 0 \, v$
- $V_D = 0.3 \, v$
- $V_B = 0.5 \, v$

d) Find $I_{DS}$ if:

- $V_G = 1.5 \, v$
- $V_S = 0 \, v$
- $V_D = 2.0 \, v$
- $V_B = 0.5 \, v$

e) Run a DC simulation using S-Edit & T-SPICE to verify your calculations in 2.a-2.d. Consider using an ideal DC voltage source to set the body terminal of the NMOS to 0.5v. You are to produce a single IV plot that indicates the solutions for all 4 of your calculations. Indicate clearly on your plot the current from parts 2.a-2.d. Also turn in a print of your final S-edit schematic.
3) Ideal P-Channel MOSFET IV Characteristics:
   (3 Points)

For the following P-Channel, enhancement-type MOSFET.

\[ \begin{align*}
V_{T0} & = -0.49 \text{ v} \\
k' & = 63 \text{ } \mu\text{A}/\text{V}^2 \text{ (notice the } \mu\text{A and the ') } \\
W & = 5 \text{ } \mu\text{m} \\
L & = 0.25 \text{ } \mu\text{m} \\
\lambda & = 0.05
\end{align*} \]

a) Find \( I_{DS} \) if:
   \[ \begin{align*}
V_G & = 1.5 \text{ v} \\
V_S & = 2.5 \text{ v} \\
V_D & = 2.2 \text{ v} \\
V_B & = 2.5 \text{ v}
\end{align*} \]

b) Find \( I_{DS} \) if:
   \[ \begin{align*}
V_G & = 1.5 \text{ v} \\
V_S & = 2.5 \text{ v} \\
V_D & = 0.5 \text{ v} \\
V_B & = 2.5 \text{ v}
\end{align*} \]

c) Find \( I_{DS} \) if:
   \[ \begin{align*}
V_G & = 1.0 \text{ v} \\
V_S & = 2.5 \text{ v} \\
V_D & = 2.2 \text{ v} \\
V_B & = 2.5 \text{ v}
\end{align*} \]

d) Find \( I_{DS} \) if:
   \[ \begin{align*}
V_G & = 1.0 \text{ v} \\
V_S & = 2.5 \text{ v} \\
V_D & = 0.5 \text{ v} \\
V_B & = 2.5 \text{ v}
\end{align*} \]

e) Run a DC simulation using S-Edit & T-SPICE using the Generic 0.25um Level 1 model to verify your calculations in parts 3.a-3.d. The parameters for your hand calculations above were taken from the SPICE model so the simulations should match your solutions. You are to produce a single IV plot that indicates the solutions for all 4 of your calculations (i.e., \( V_{ds} \) vs. \( I_{ds} \)). Indicate clearly on your plot the current from parts a-d. Also turn in a print of your final S-edit schematic.