1. Given:
   \( V_{\text{gs}} = V_{\text{in}} - V_{DD} \)
   \( V_{DD} = 5 \text{V} \)
   \( V_{gs} = 3.2 \text{V} \)
   \( V_{gs} = 3.2 - 5 \text{V} \)
   \( V_{out} = V_{ds} \)
   \( V_{gs} = V_{in} \)

   \( V_{in} = 3.2 \text{V} \), \( V_{DD} = 5 \text{V} \), \( V_{th} = 1 \text{V} \), \( V_{tp} = -1 \text{V} \)

   and both transistors are in saturation.

   We know:

   \[ I_{ds} = \beta \left( \frac{V_{gs} - V_{th}}{2} \right)^2 \]

   For inverter, both devices are in saturation when

   they are in Region C and these currents are equal.

   Hence:

   \[ I_{dsn} = -I_{dsp} \]

   \[ \Rightarrow \beta_n = \frac{(V_{gs} - V_{th})^2}{(V_{gs} - V_{th})^2} \]

   \[ \Rightarrow \frac{\beta_n}{\beta_p} = \frac{(V_{gs} - V_{tp})^2}{(V_{gs} - V_{tn})^2} \]

   \[ \Rightarrow \frac{\beta_n}{\beta_p} = \frac{[-1 - (-1)]^2}{[3.2 - 1]^2} = \frac{0.13}{0.9} = 0.13 \]

   \[ \Rightarrow \beta_n = 0.13 \]
All p-type transistors whose source is not connected to VDD and all n-type device whose source is not tied to ground experience body effect.

Hence 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 devices experience body effect.
3. The PMOS device exhibiting body effect will have current of smaller magnitude because for given \( V_{gs} \) since its threshold voltage is more than that of device without body effect which is evident from \( I_{ds} \) equation.

\[
I_{ds} = -\frac{1}{2}(V_{gs} - V_{tp})^2
\]

for given \( V_{gs} \) if \( V_{tp, body effect} > V_{tp} \)

Hence

\[
I_{ds}(body effect) < I_{ds}(without body effect)
\]

which is also for \( I_{ds} \) in linear region.

4. Given for PMOS:

\[
V_{gs} = -2.5 \text{V}, V_{dp} = -0.5 \text{V} \text{ & } V_{tp} = -1 \text{V}.
\]

\[
V_{gs} - V_{tp} = -2.5 - (-1) = -1.5 \text{V}
\]

\[
V_{dp} \Rightarrow V_{gs} - V_{tp} \text{ & } V_{gs} < V_{tp}.
\]

Pms device in \boxed{saturation, linear region}.

Given

\[
V_{gs} = -3.5 \text{V}, V_{dp} = -4.6 \text{V}.
\]

\[
V_{gs} - V_{tp} = -3.5 - (-1) = -2.5 \text{V}
\]

\[
V_{dp} < V_{gs} - V_{tp} \text{ & } V_{gs} < V_{tp}
\]

PMOS device in \boxed{saturation, linear region}.
3) For NMOS Device

\[ V_{GSN} = 2\text{.}0\text{V} \quad \text{&} \quad V_{TH} = 1\text{V} \]

If NMOS device is in Saturation region of operation then:

\[ V_{DSN} > V_{GSN} - V_{TH} \]

\[ V_{DSN} > 2\text{.}0 - 1 \]

\[ \Rightarrow \quad V_{DSN} > 1\text{V} \]

And for Supply Voltage of \( V_{DD} = 5\text{V} \) and \( G_{NN} = 0\text{V} \),

the upper limit of \( V_{DSN} \) which \( V_{DD} - V_{S} = 5\text{V} \).

The range of values of \( V_{DSN} \) in

\[ 0 < V_{DSN} \leq 5\text{V} \]

\[ \left( \begin{array}{c}
\text{d}
\end{array} \right) \]

\[ \begin{array}{c}
V_{in} = 4\text{V} \\
S
\end{array} \]

\[ \begin{array}{c}
V_{DSN} = V_{D} - V_{S} \\
= 4 - 1 = 3\text{V} \end{array} \]

The source, drain regions of NMOS transistor in shown in the figure above.
At $t = 0^+$

$V_{DSN} = V_D - V_S = V_{OUT} - V_{IN} = (4-1) = 3V.$

$V_{GSN} = V_G - V_S = V_G - V_{IN} = (5-1) = 4V.$

The NMOS device is subjected to body effect because source is not tied to ground.

Assuming $V_{TH} = 1.2V$

$V_{GSN} - V_{TH} = 4 - 1.2 = 2.8V.$

$V_{DSN} > V_{GSN} - V_{TH}$

At $t = 0^+$ NMOS device is in saturation region of operation.

Over period of time $V_{OUT}$ drops from its initial value of $4V$ because PMOS device is in saturation region of operation.

When $V_{OUT}$ value falls to $1V$ then PMOS device is out of operation.

Hence at $t = \infty$

$V_{GSN} = V_G - V_{IN} = (5-1) = 4V.$

$V_{DSN} = V_{OUT} - V_{IN} = 1 - 1 = 0V.$

$V_{GSN} - V_{TH} = 4 - 1.2 = 2.8V.$

$V_{DSN} < V_{GSN} - V_{TH}$

The NMOS device is in linear region of operation.
The noise margin for an inverter is

\[ \text{Noise Margin (High)} = \text{NM} = V_{\text{on min}} - V_{\text{IH min}}. \]

Given \( V_{\text{on min}} = 2.8\text{V} \) and \( V_{\text{IH min}} = 3.0\text{V} \),

\[ \text{NM}_{\text{H}} = 3.8 - 3.0\text{V} = 0.8\text{V}. \]

The final input voltage of the transistor is \( V_{\text{in}} - V_{\text{TH (body effect)}} \)

when \( V_{\text{g}} = V_{\text{in}} - V_{\text{TH (body effect)}} \) and \( V_{\text{gs}} = V_{\text{TH (body effect)}} \) which turns off the transistor.

The final value of \( V_{\text{out}} = -V_{\text{TP (body effect)}} \) because the load capacitor discharges through the device until \( V_{\text{out}} = V_{\text{TP (body effect)}} \), at which point the device is turned off.