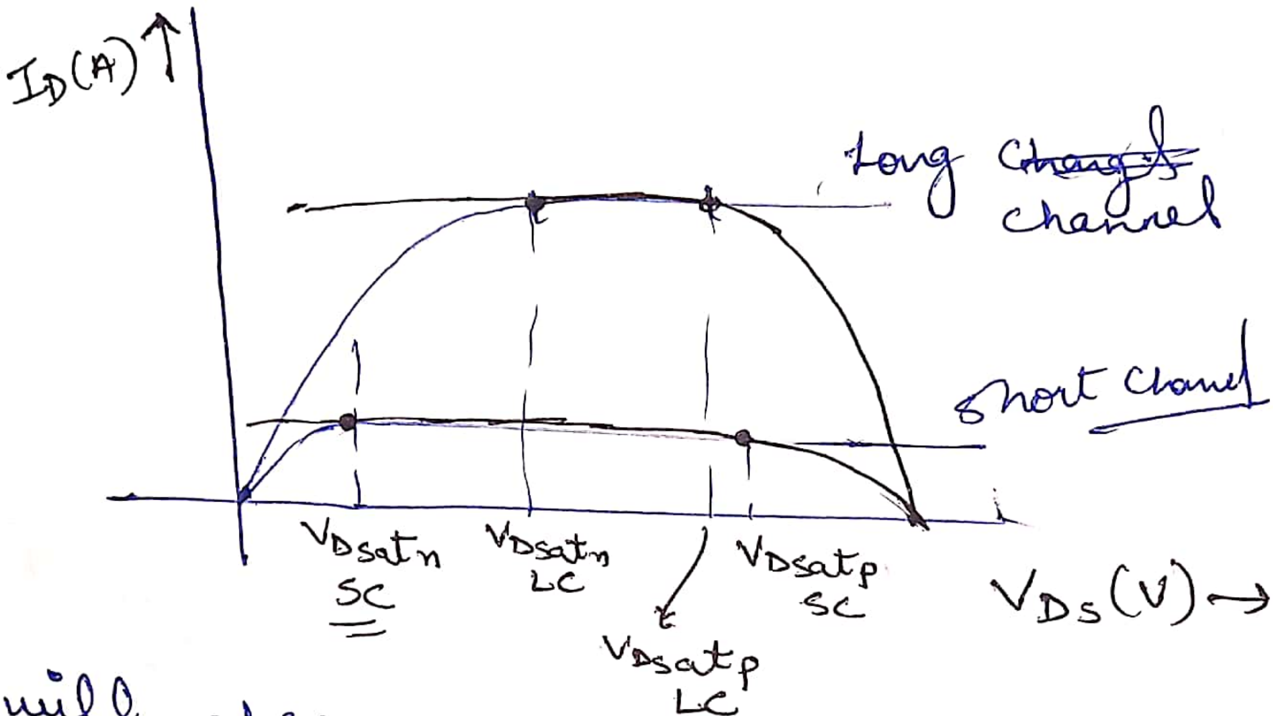
Quiz 4 Solution

Q1)



We will observe a steep slope for larger values of voltage in short channel because both NMOS & PMOS in short channel attain saturation early as compared to long channel.

1

1

Q2) The sub threshold leakage current of MOSFET does not affect swing of CMOS Inverter.

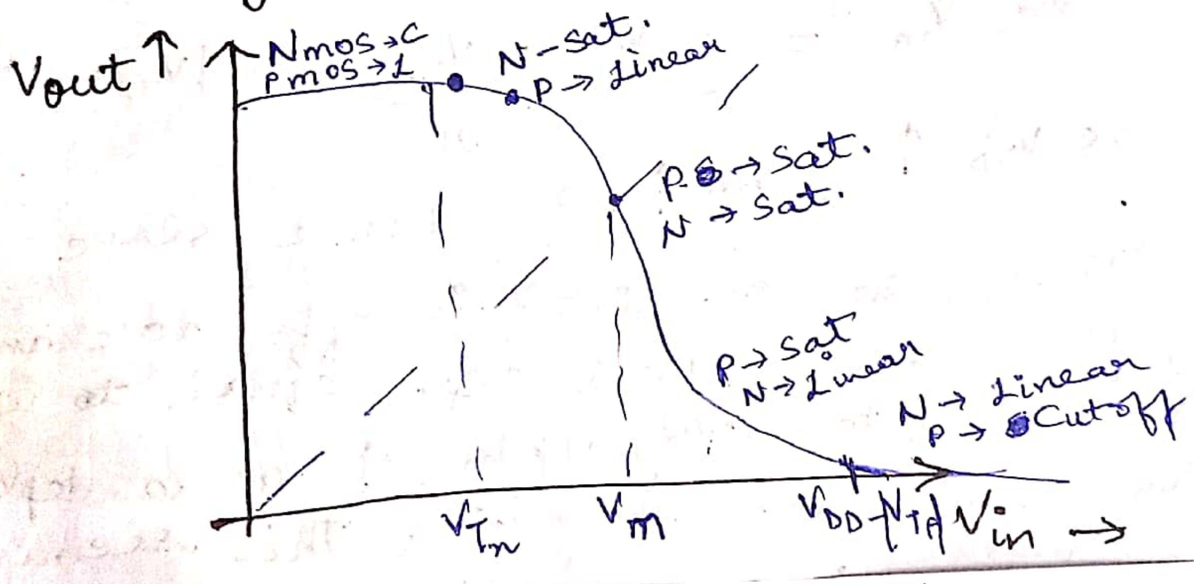
Let say, V_{in} = logic low,
The current flowing from PMOS will be charging Load Cap. while subthreshold current flowing through NMOS will be discharging it.

$I_{subthreshold} << I_{PMOS}$

so $V_{OH} = V_{DD}$ & $V_{OL} = 0\,V$

1 tank filling analogy

Q3) This Question can be answered by drawing the VTC.



a) When
$V_{tn} < V_{in}$ → NMOS → Sat.
PMOS → Linear

1

$V_{in} \le V_m$ → NMOS → Sat.
PMOS → Sat.

b) $V_m \le V_{in} \le V_{DD} - |V_{tp}|$

1

→ NMOS → Linear
→ PMOS → Sat.

Q4) For creating an pmos, we need two heavy doped p^+ regions with n-doped body. So we need an additional n well which denotes the body of pmos. 1

Q5] 1) To avoid / prevent current crowding 1

2) To reduce contact resistance. 1

Q6) Infinite , becomes finite or decreases 1

Q7) V_{Tn} to $V_{DD} - |V_{Tp}|$ 1

Q8) Statement is incorrect

Increasing supply voltage $\uparrow$ power dissipation

as $P \propto V_{DD}$ 1

But $\uparrow V_{DD} \rightarrow \downarrow$ slope of VTC

as

$$\frac{dV_o}{dV_{in}} = g = -\frac{1 + \sqrt{\frac{K_p}{K_n}}}{(\lambda_n - \lambda_p)\left(\frac{V_m - V_T}{2}\right)}$$

& $$V_m = \frac{r V_{DD} + V_{Tn} - r|V_{Tp}|}{r}$$

as $V_{DD} \uparrow$, $V_m \uparrow$ & hence slope $\downarrow$

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Q9) When $V_{GS} = 0$, transistor is off
→ no channel formation & total Cap. equal to WLC_{ox} appears b/w gate & body.
When $V_{GS} \uparrow$, a depletion region forms under the gate.
Once the transistor enters to ~~saturation~~ sub threshold region, the channel starts to form and drop in C_{GCB} must be observed before V_T not exactly at V_T

Once channel forms, it shields body

The device operates in the Resistive mode & the Cap. divides equally b/w source & drain.

$$C_{GCS} = C_{GCD} = \frac{WLC_{ox}}{2}$$

2

10) Gate Channel Capacitance (C_{GC}) ③

$C_{GC} = C_{ox} W L + 2 C_{ox} W$

$C_{GC} = \frac{2}{3} C_{ox} W L + 2 C_{ox} W$

& $C_{ox} = \frac{\epsilon_{ox}}{t_{ox}}$

for those who answered "NO" ②

So clearly it can be seen that C_{GC} does not depend on doping conc.

or But we know that, V_T depends upon doping and C_{GC} is a function of V_{GS}. So C_{GC} changes with doping.

even if they answered "yes" & gave this logic → ②

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