Assignment - 2

Group - 6

Section - B

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$$X = (14 + 18 + 20) \bmod 3$$
$$= 52 \bmod 3$$
$$= 1$$

$$Y = \text{Cube}(X) \bmod 6 + 1$$
$$= 1^3 \bmod 6 + 1$$
$$= 2$$

$$Z = (X + 3 * Y) \bmod 5 + 1$$
$$= (1 + 3 * 2) \bmod 5 + 1$$
$$= 2 + 1$$
$$= 3$$

Ans to the question n:o-1

Given, $\frac{w_1}{L_1} = Y$

$k = 6$

$C_{out} = (0.10 + Z)\ pF$

$\therefore \frac{w_1}{L_1} = 2$

$C_{out} = (0.10 + 3)\ pF$
$= 3.10\ pF$

we know,

$$K = \left(\frac{w_1}{L_1}\right) / \left(\frac{w_2}{L_2}\right)$$

$$\Rightarrow \frac{w_2}{L_2} = \left(\frac{w_1}{L_1}\right) / K$$

$$\Rightarrow \frac{w_2}{L_2} = 2/6$$

$$\therefore \frac{w_2}{L_2} = \frac{1}{3}$$

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we know, the rise time of a NMOS inverter with depletion transistor load is,

$$t_r = \frac{60\ C_{out}}{W_2/L_2}\ ns$$

so, $$t_r = \frac{60 \times 3.10}{1/3}\ ns$$

$$= 60 \times 3.10 \times 3$$

$$= 558\ ns$$

fall time, $$t_f = \frac{35\ C_{out}}{W_1/L_1}$$

$$= \frac{35 \times 3.10}{2}$$

$$= 54.25\ ns$$

Maximum frequency of the inverter circuit is,

$$f_{max} = \frac{1}{t_r + t_f}$$

$$= \frac{1}{558 + 54.25}\ GHz$$

$$= 1.63 \times 10^{-3}\ GHz$$

$\therefore f_{max} = 1.63$ MHz

Ans to the question n.o-2

Given,

Nmos; $\varepsilon\mu_n/D = 24+2*(x+1)\ \mu A/v^2$

$w_1/L_1 = 1$

$v_{tn} = 1v$

pmos: $\varepsilon\mu_p/D = 0.5 * \varepsilon\mu_n/D\ \mu A/v^2$

$w_2/L_2 = 2$

$v_{tp} = 1v$

So, Nmos: $\varepsilon\mu_n/D = 24+2*(1+1)\ \mu A/v^2$

$= 28\ \mu A/v^2$

pmos: $\varepsilon\mu_p/D = 0.5 * 28\ \mu A/v^2$

$= 14$

For Transistor T_1 (NMOS):

$$I_{ds_1} = \frac{\varepsilon \mu n}{D} \times \frac{w_1}{L_1} \times \frac{(V_{gs} - V_{tn})^2}{2}$$

$$= 28 \times 1 \times \frac{(V_{gs} - V_{tn})^2}{2}$$

$$= 14 \times (V_{gs} - 1)^2$$

$V_{in} = V_{gs}$

$V_{out} = V_{ds}$

$V_{ds} = V_{gs} - V_t$

V_{gs}	V_{in}	Pinchoff, $V_{ds} = V_{gs} - V_t$	$I_{ds} = 14(V_{gs}-1)^2$	$V_{out} = V_{ds}$
2	2	1	14	1
2.5	2.5	1.5	31.5	1.5
3	3	2	56	2
4	4	3	126	3
5	5	4	224	4

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For Transistor T_2 (pMOS)

$$I_{ds_2} = \frac{\varepsilon \mu_p}{D} \times \frac{W_2}{L_2} \times \frac{(V_{sg} - V_{tp})^2}{2}$$

$$= 14 \times 2 \times \frac{(V_{sg}-1)^2}{2}$$

$$= 14 \times (V_{sg}-1)^2$$

$\Rightarrow V_{sg} = V_s - V_g$

$\Rightarrow V_{sg} = V_p - V_{in}$

$\therefore V_{in} = 5 - V_{sg}$

$V_{sd} = V_s - V_d$

$\Rightarrow V_{sd} = V_p - V_{out}$

$\therefore V_{out} = V_p - V_{sd}$

$V_{sd} = V_{sg} - V_{tp}$

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V_{sg}	V_{in}	Pinchoff, $V_{sd} = V_{sg} - V_{tp}$	$I_{sd} = 14(V_{sg} - 1)^2$	$V_{out} = V_p - V_{sd}$
2	3	1	14	4
2.5	2.5	1.5	31.5	3.5
3	2	2	5.6	3
4	1	3	1.26	2
5	0	4	22.4	1

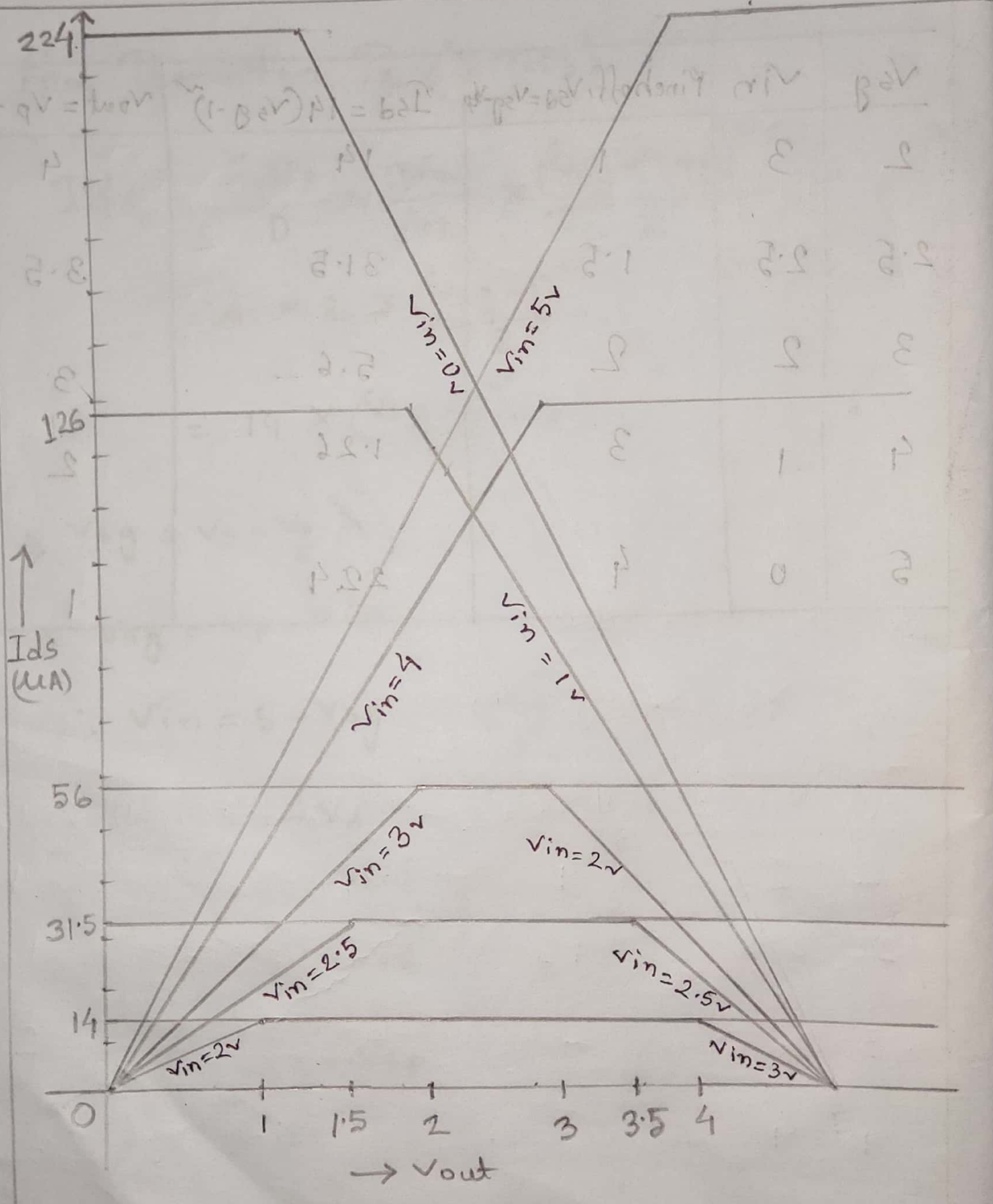

fig: I vs Vout charastie curve for cmos inverter

To get the power graph we can calculate using the information from I vs Vout graph.

Vin	Vout	I
0	5	0
1	5	0
2	4.5	14
2.5	1.5 to 3.5	31.5
3	0.5	14
4	0	0
5	0	0

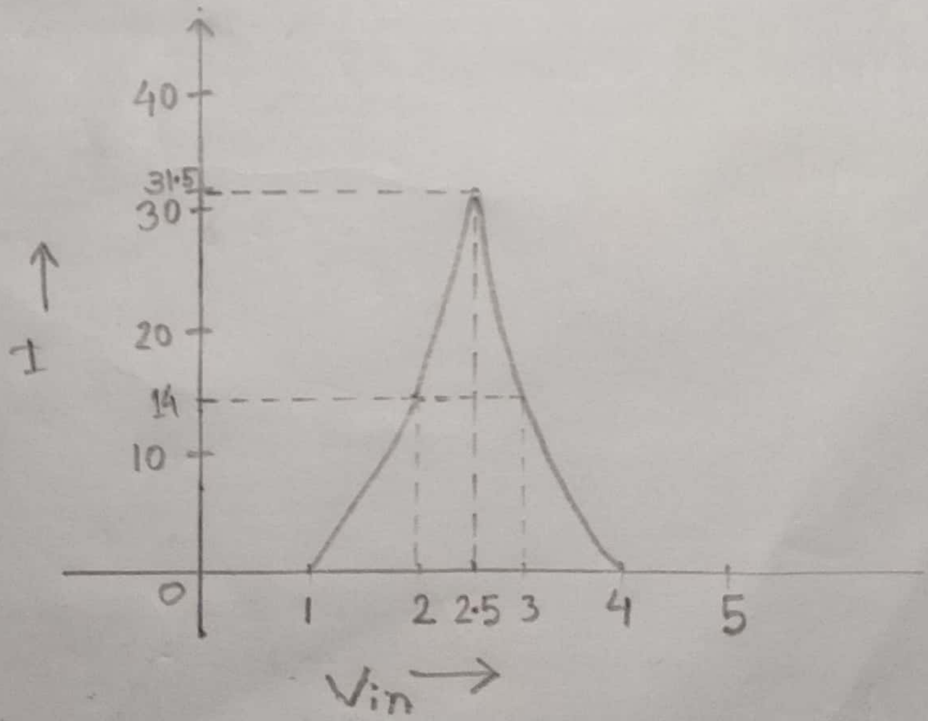

fig: Power curve (I vs Vin) For CMOS Inverter

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