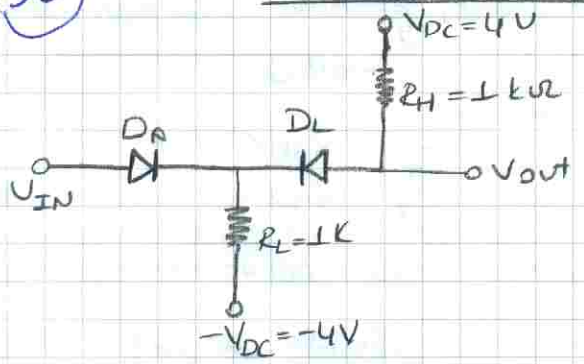
EE-282
HOMEWORK - III

(30) 100

1)

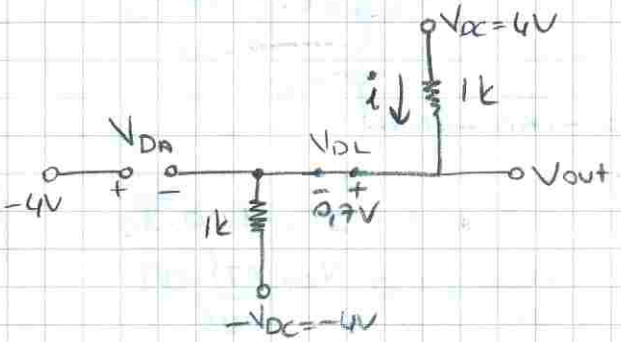


Because $-V_{DC} < V_{IN} < V_{DC}$

$-4V < V_{IN} < 4V$

Graph is bounded by $V_{IN}=-4V$ & $V_{IN}=4V$

Assume that D_A is OFF and D_L is ON when $V_{IN}=-4V$



$$i = \frac{4-(-4)-0,7}{2k} = \frac{7,3}{2k} = 3,65\ mA$$

$i = 3,65\ mA > 0$ (So assumption which is D_L is ON, is TRUE)

$$V_{DA} = -4-(4-3,65-0,7)$$
$$= -4-(-0,35)$$
$$= -4+0,35 = -3,65 < 0$$

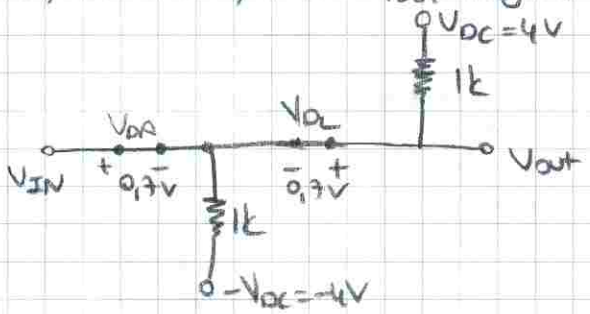
(So assumption which is D_A is OFF, is TRUE)

Then $V_{out} = 4-3,65 = 0,35\ V$

When V_{IN} reaches $0,35\ V$, D_A becomes ON. Because,

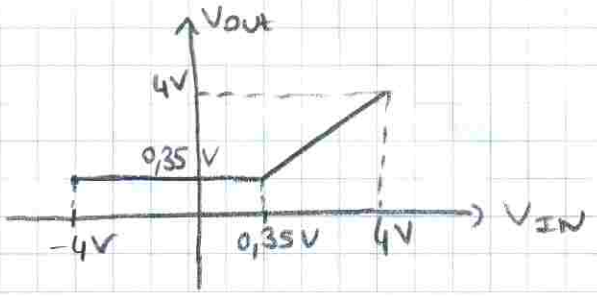
$V_{DA} = 0,35-(-0,35) = 0,7\ V$

After that point V_{out} begins to increase

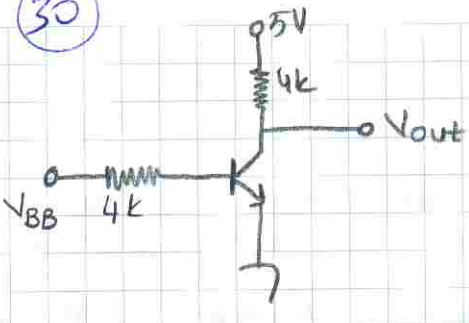


As V_{IN} increases, V_{out} increases at the same rate. Because V_{DA} and V_{DL} cancels each other, and $V_{IN}=V_{out}$

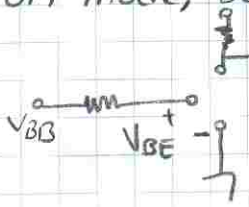
So the graph should be



2) (30)



When $0 < V_{BB} < 0,7\ V$, the transistor is in OFF mode, because $V_{BE} < 0,7\ V$

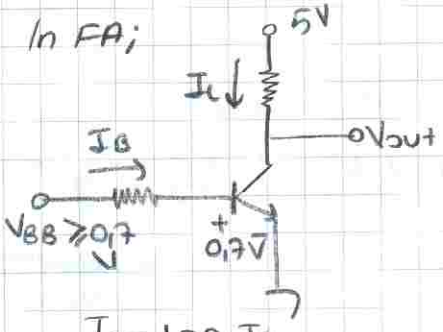


$V_{BE} < 0,7\ V$

$V_{out} = 5\ V$, since there is no current.

When $V_{BB} = 0,7$, the transistor turns on and passes to the forward Active mode.

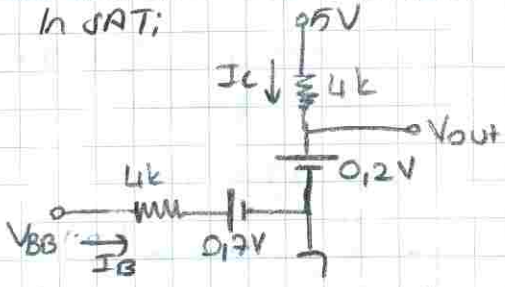
In FA;



$I_C = 100 . I_B$

Then transistor reaches saturation model

In SAT;



At SAT point, $I_C = 100 . I_B$

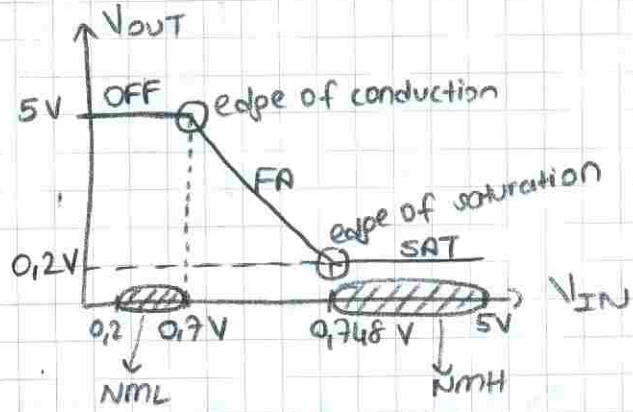
$$\frac{5 - 0,2}{4k} = 100 . \frac{V_{BB(SAT)} - 0,7}{4k}$$

$$0,048 = V_{BB(SAT)} - 0,7$$

$$V_{BB(SAT)} = 0,748\ V$$

and $V_{out} = 0,2\ V$

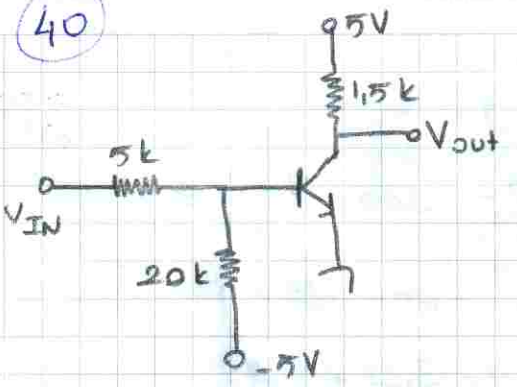
So the VTC;



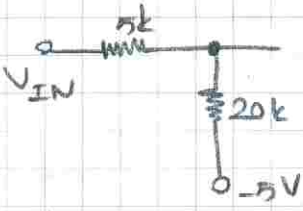
$NMH = V_{OH} - V_{IH} = 5\ V - 0,748\ V = 4,252\ V$

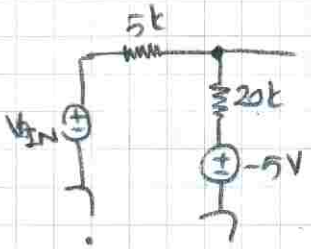
$NML = V_{IL} - V_{OL} = 0,7\ V - 0,2\ V = 0,5\ V$

3) (40)

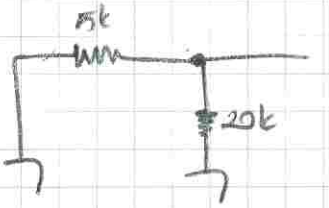


In order to solve the problem, first we should find the Thevenin equivalent of the left hand side.

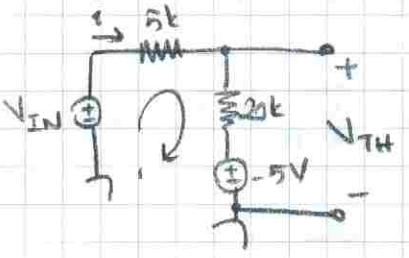




To find R_{TH} kill the sources ⟹



$R_{TH} = 5k \,//\, 20k$
$= \underline{4k}$



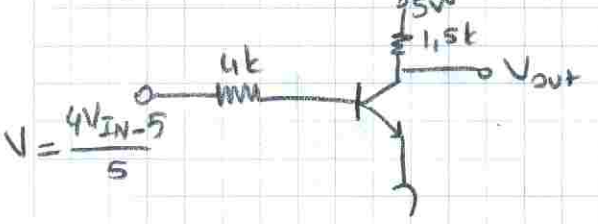
KVL

$$-V_{IN} + 5k\,i + 20k\,i - 5 = 0$$

$$i = \frac{V_{IN}+5}{25k}$$

$$V_{TH} = \frac{20k}{25k}\cdot\frac{V_{IN}+5}{4} - 5 = \frac{4V_{IN}+20-25}{5} = \frac{4V_{IN}-5}{5}$$

So the circuit changes to;



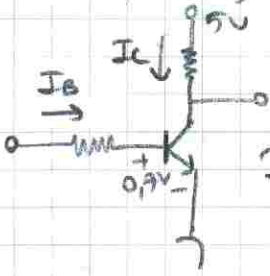
When $0 < V < 0,7$ V, the transistor is in OFF mode, because $V_{BE} < 0,7V$

$V_{BE} < 0,7V$

$V_{out} = 5V$, (no current)

When $V = 0,7$ V, the transistor turns on and passes to Forward Active mode.

$V = 0,7\,V = \frac{4V_{IN}-5}{5} \Rightarrow V_{IN} = \frac{8,5}{4} = 2,125$ V (When transistor is at the edge of conduction)



$I_C = I_B \cdot \beta_F$

Then transistor reaches SAT mode!

⟹