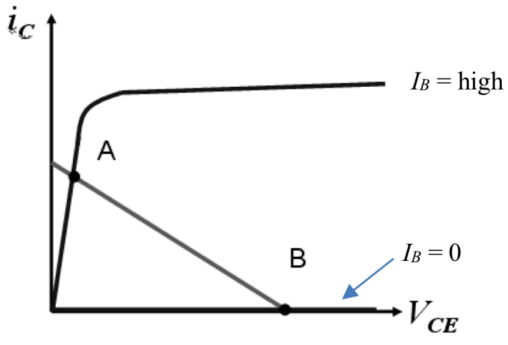
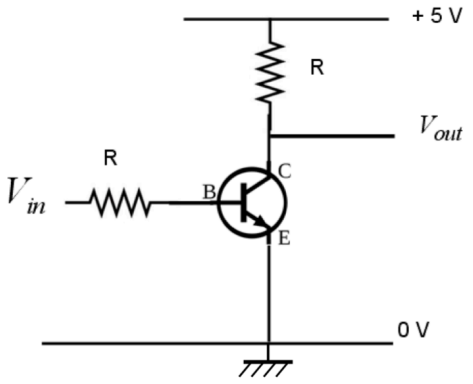
Prelab 9 Solutions (2019)

The figure shows part of the characteristic curves for an NPN. The transistor is biased using two 10 kΩ resistors. The BE junction turns on at about 0.6 V. The load line is shown with A indicating the point with the transistor on (input high), and B indicating the point with the transistor off (input low).





a) What is the value of V_{out} at point B and why? What range of values of V_{in} does this correspond to?

$V_{out} = V_{cc} = +5V$ for $V_{in} \lesssim 0.6V$

For $V_{in} \lesssim 0.6V$, the BE junction is open,

i.e. base current ~ zero

$\Rightarrow I_C = 0 \Rightarrow V_{CE} = V_{OUT} = 5V$

b) If the value of V_{CE} is 0.1 V at point A, what is the value of V_{out} when $V_{in} = +5$ V?

$V_{out} = V_{CE} = 0.1V$

For $V_{in} = 5V$, the BE junction is closed

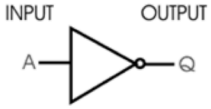
$\Rightarrow I_B$ is max (or high)

$\Rightarrow I_C$ is max $\Rightarrow V_{CE} = V_{out} \tilde{=} 0.1V$

c) Fill out the logic table for the AND and NAND functions of two input variables, ie:

AND symbol:

Inverter symbol:



A	B	$A \bullet B$	$\overline{A \bullet B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

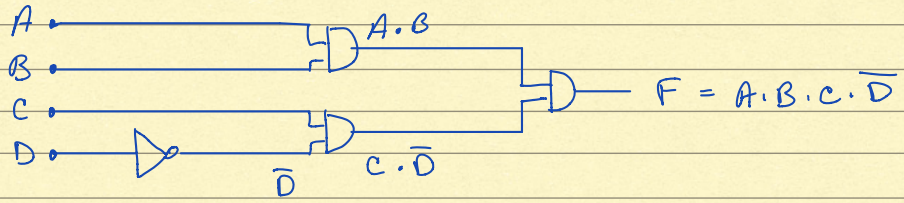
d) Draw diagrams for 2 logic circuits to identify the binary numbers 1110 and 1010 using only AND and NOT gates. To identify the bits, use input labels (A, B, C, D). Your output should be F = 1 when the input corresponds to the binary number to be identified, and F =0 for any other inputs.

(i) $ABCD = 1110 \Rightarrow ABC\bar{D} = 1111$

Then $A \cdot B \cdot C \cdot \bar{D} = 1$ for $ABCD = 1110$

$= 0$ otherwise

Using AND and NOT gates,



(ii) $ABCD = 1010 \Rightarrow A\bar{B}C\bar{D} = 1111$

Then, $A \cdot \bar{B} \cdot C \cdot \bar{D} = 1$ for $ABCD = 1010$

$= 0$ otherwise

Using AND and NOT gates: