BJT Overview
Characteristics (H.1)

20170113

.

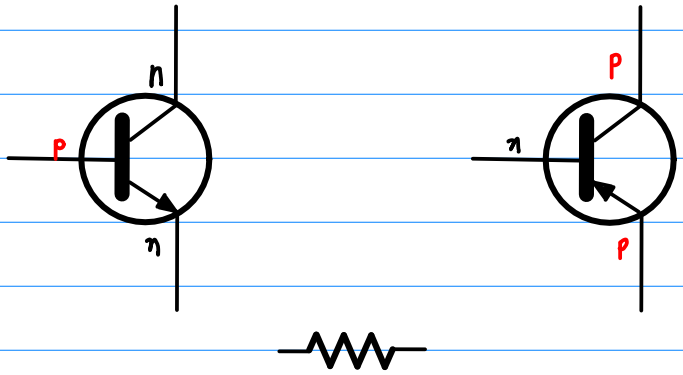
Copyright (c) 2016 - 2017 Young W. Lim.
Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled "GNU Free Documentation License".

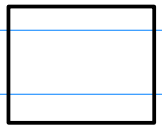
References

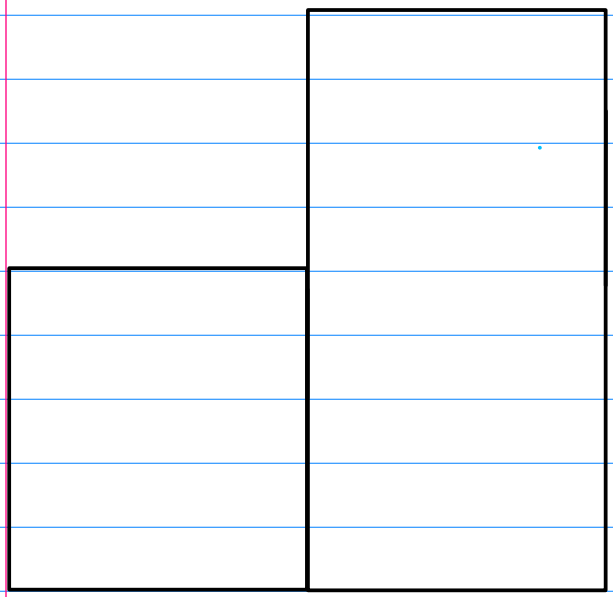
Based

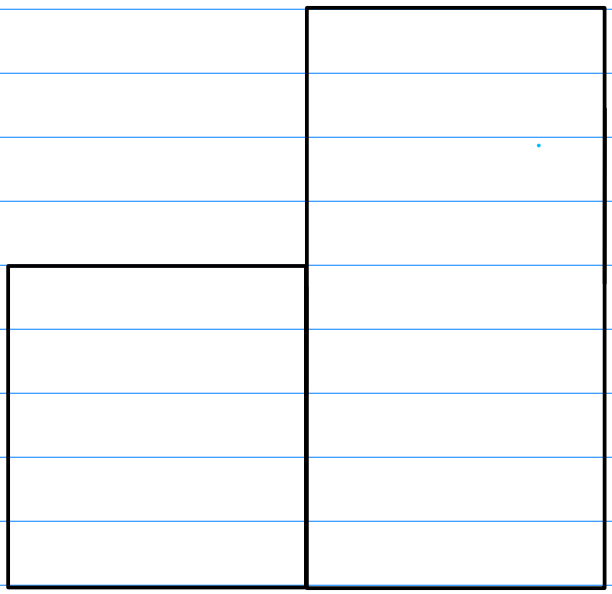
[1] Floyd, Electronic Devices 7th ed
[2] Cook,

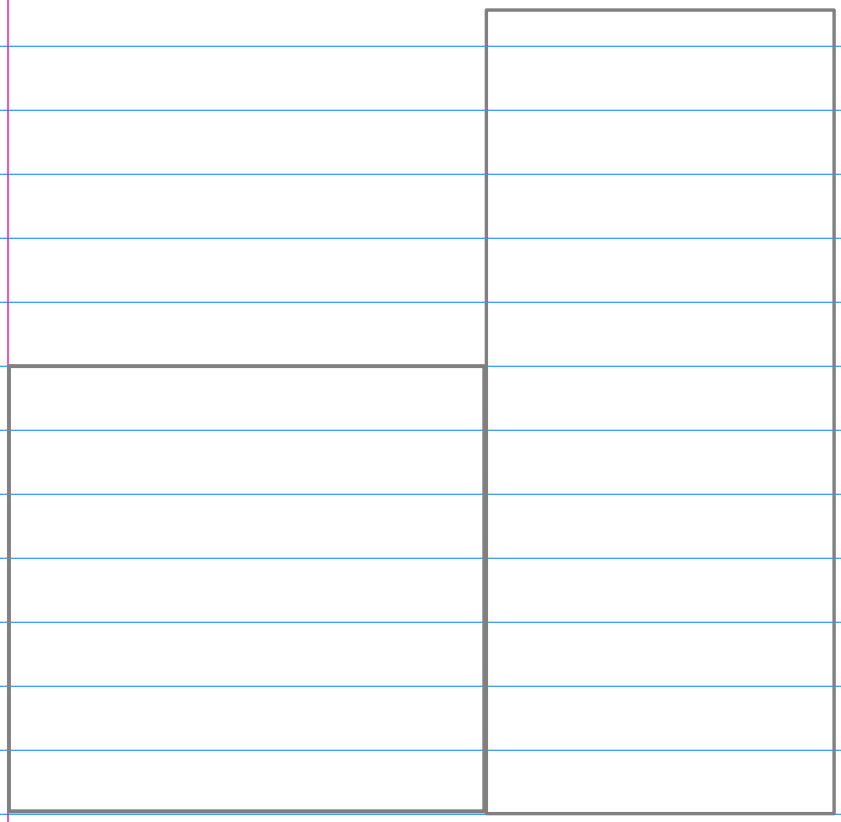
[2] en.wikipedia.org

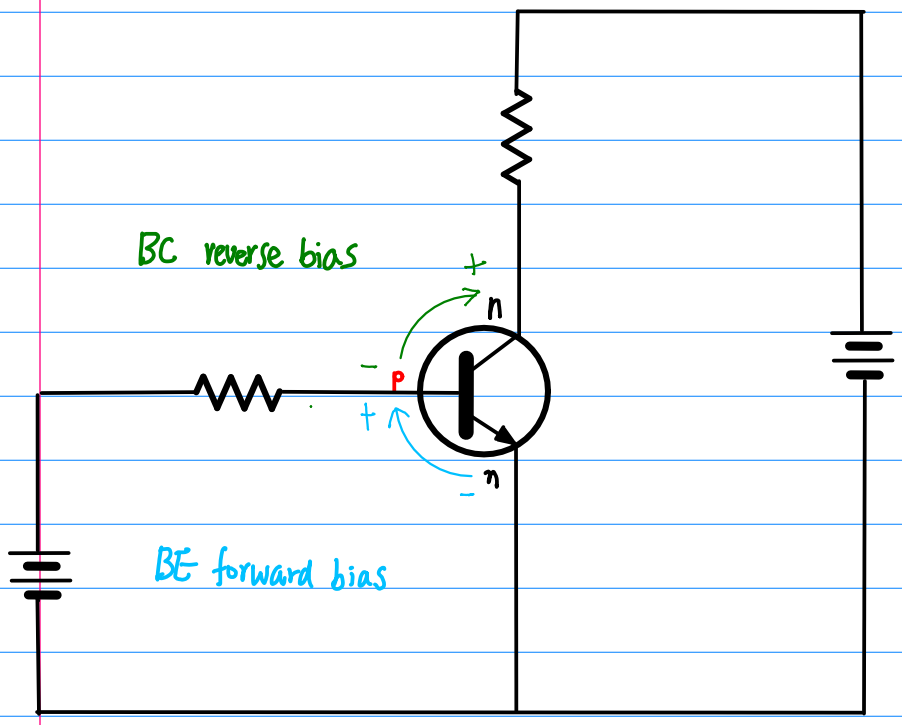

n
P
n
P
n
P

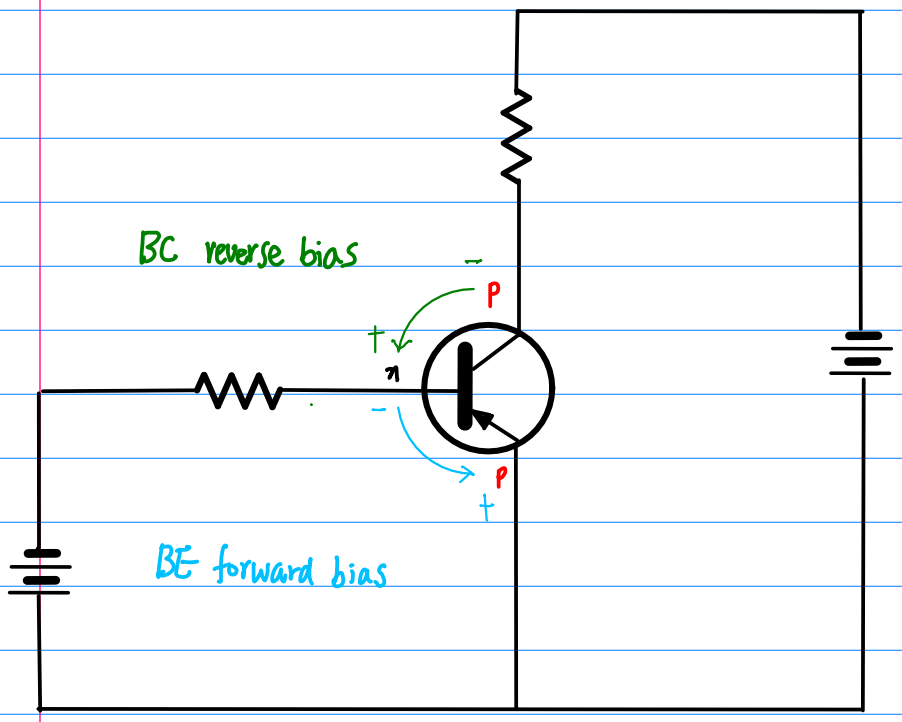




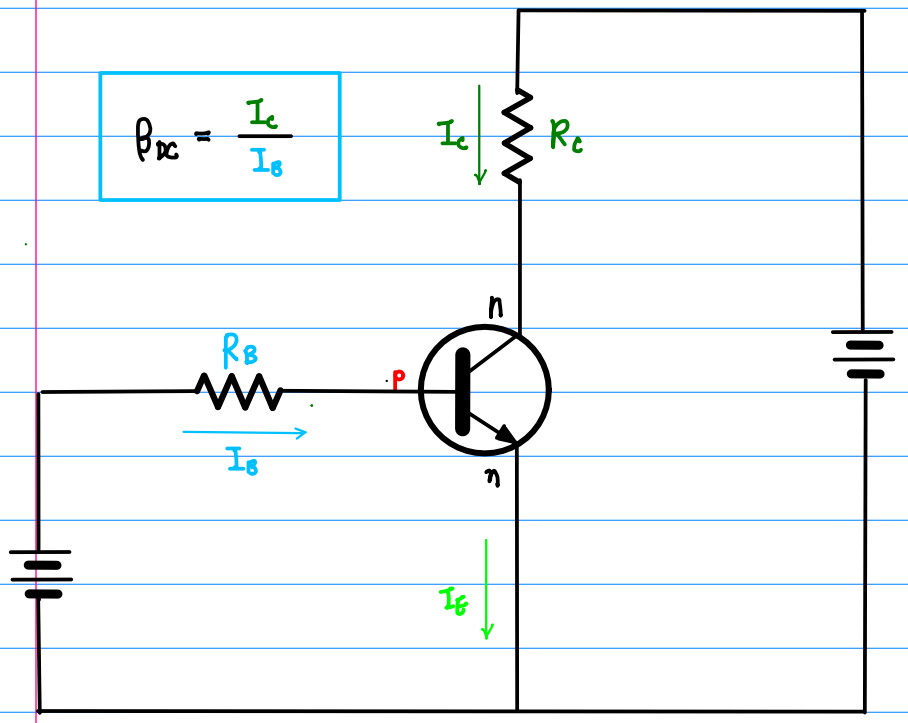





BC reverse bias
+
n
−
P
+
−
n
BE forward bias

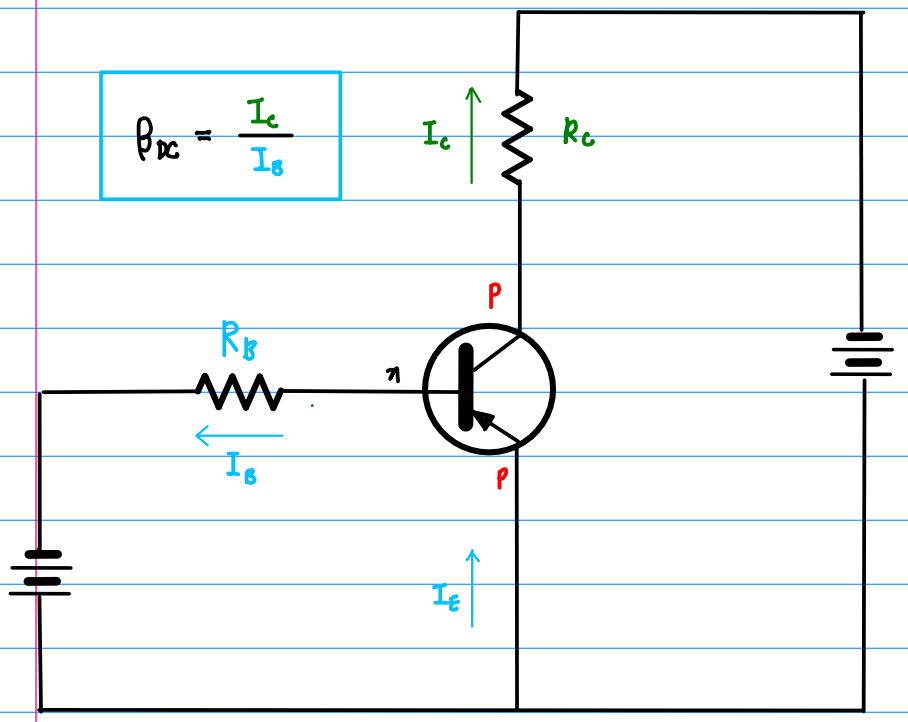

BC reverse bias
−
P
+
n
−
P
+
BE forward bias

$\beta_{DC} = \frac{I_C}{I_B}$



$\alpha_{DC} = \frac{I_C}{I_E}$

$\beta_{DC} = \frac{I_C}{I_B}$

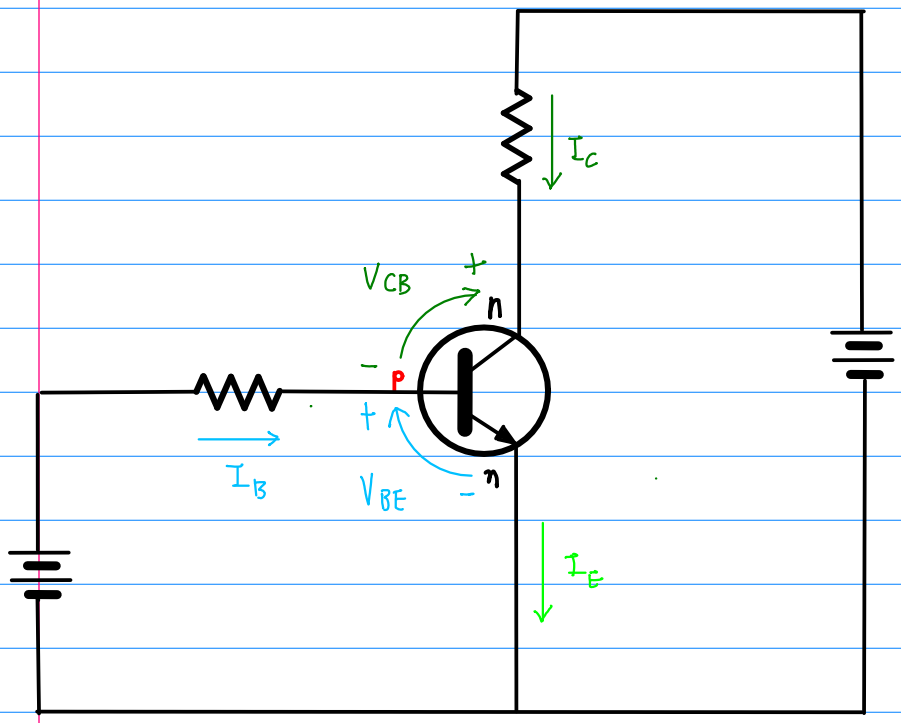


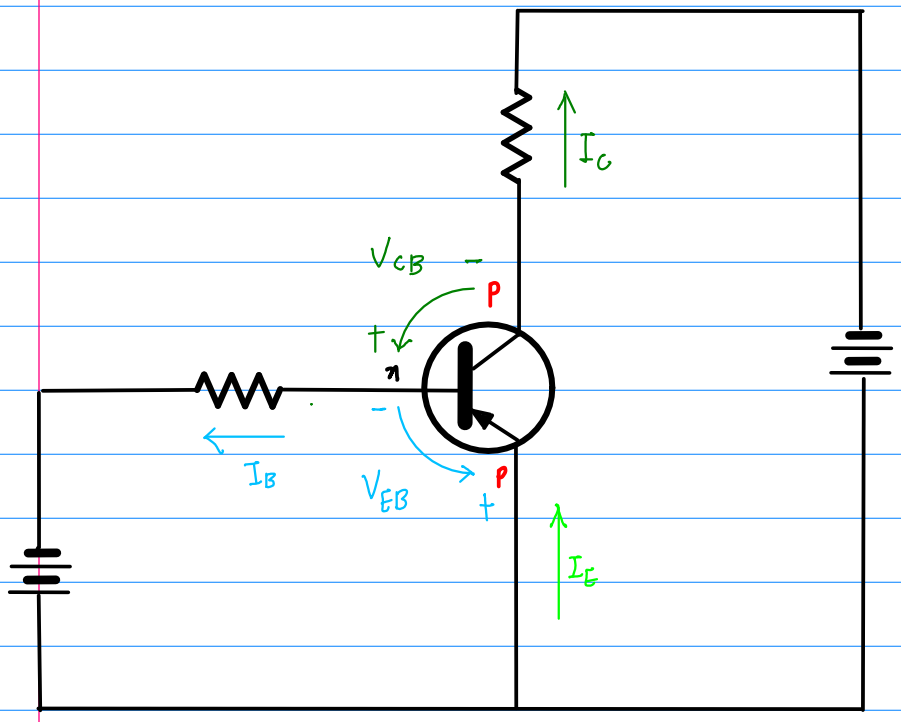
$\alpha_{DC} = \frac{I_C}{I_E}$

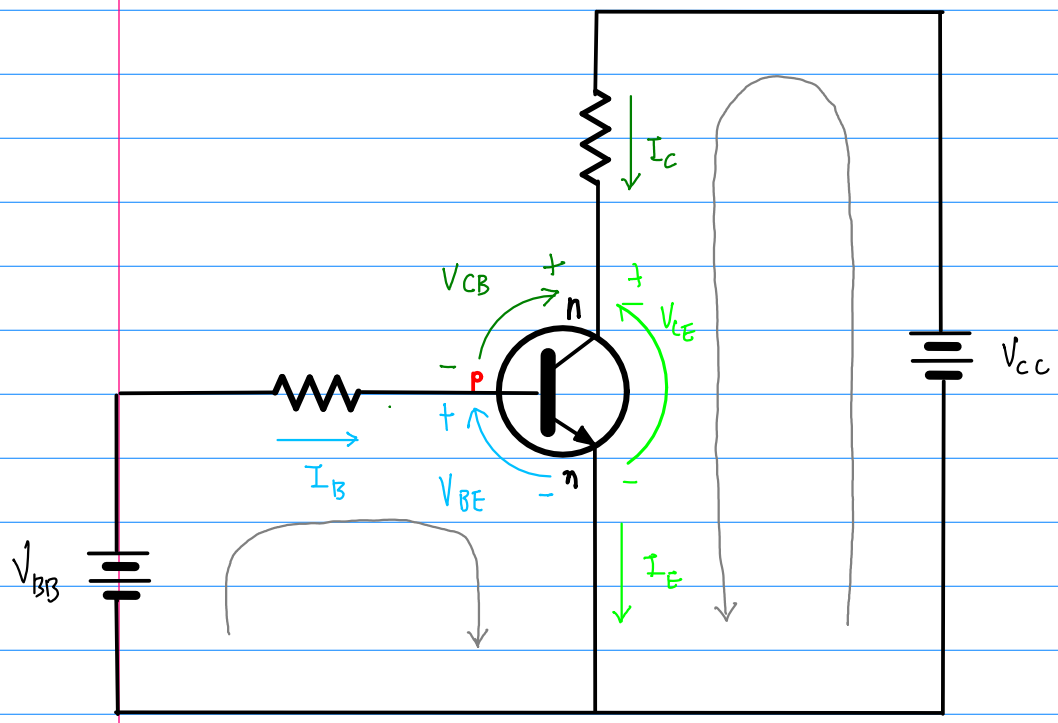
$$\beta_{DC} = \frac{I_C}{I_B}$$ 20 ~ 200

$$h_{FE} = \beta_{DC}$$

$$\alpha_{DC} = \frac{I_C}{I_E}$$ 0.95 ~ 0.99

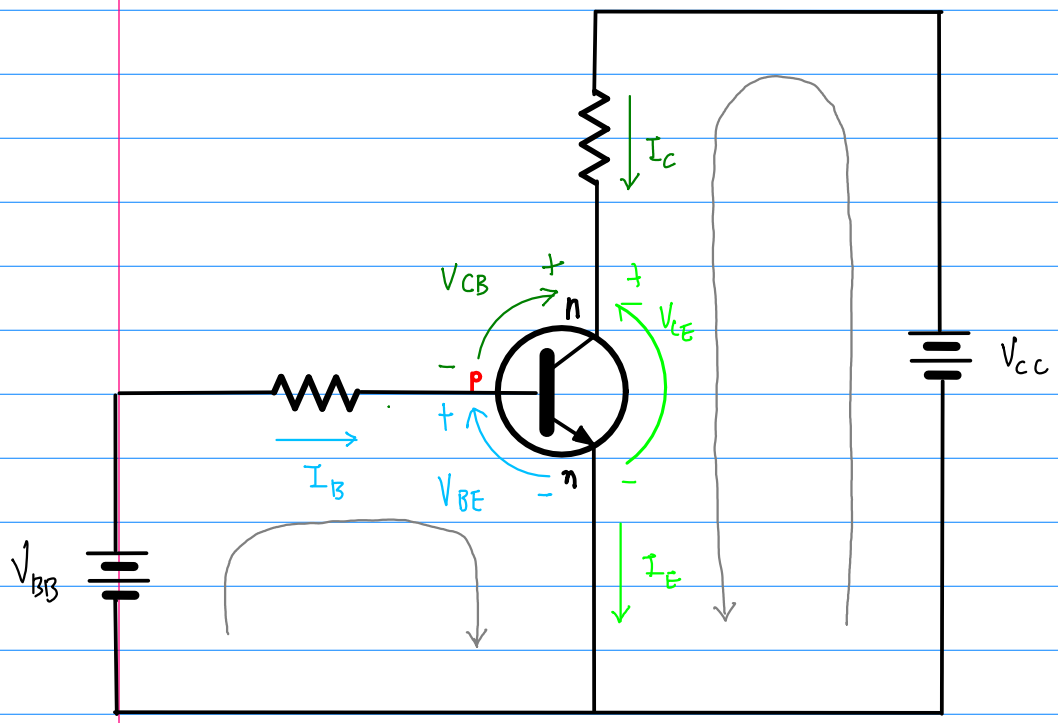

I_C
V_{CB}
+
n
−
P
+
I_B
V_{BE}
−
n
I_E

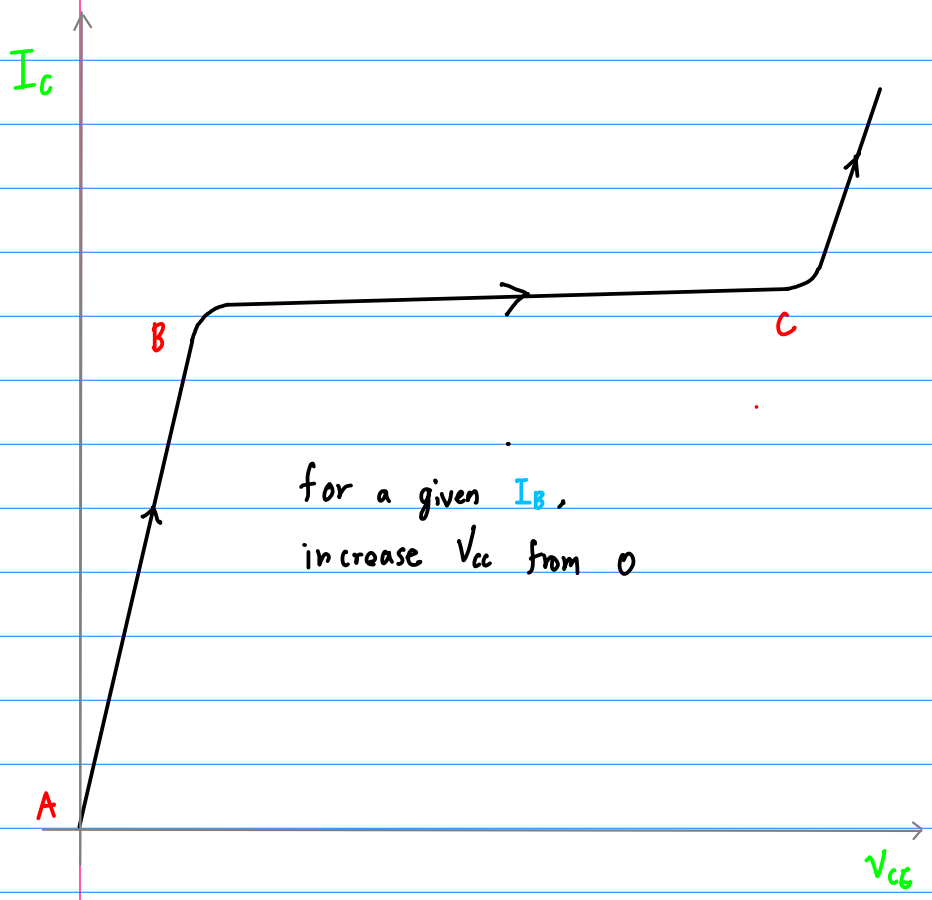

I_C
V_{CB}
−
P
+
n
−
I_B
V_{EB}
+
P
I_E



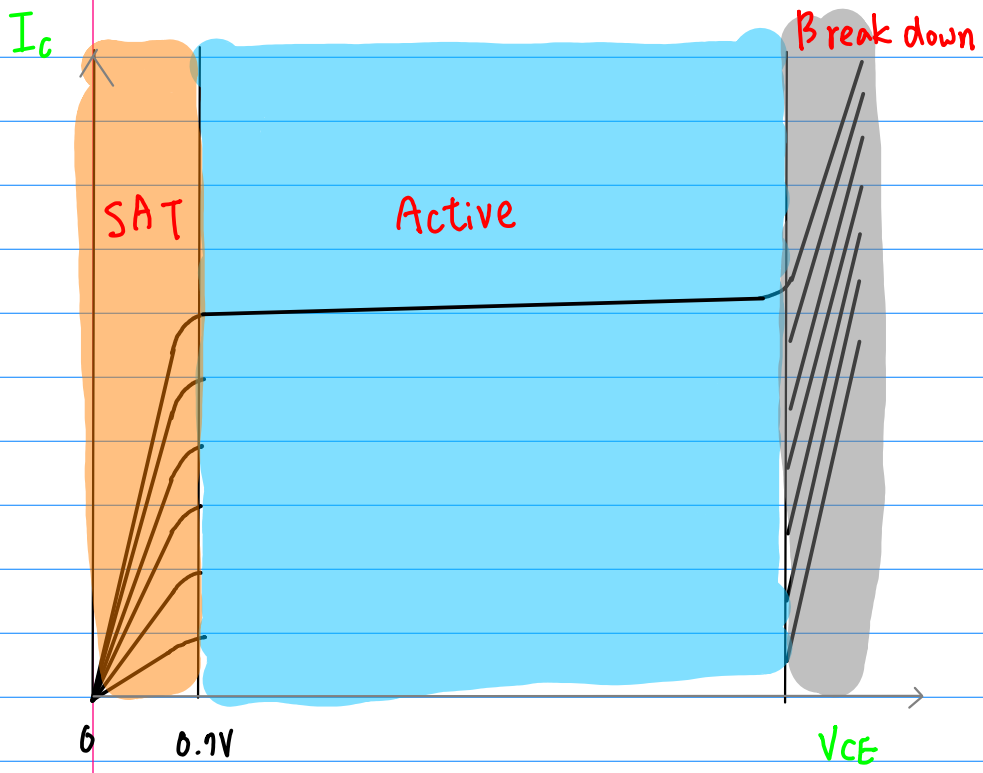
$$V_{BB} = I_B R_B + V_{BE} \qquad V_{CC} = I_C R_C + V_{CE}$$

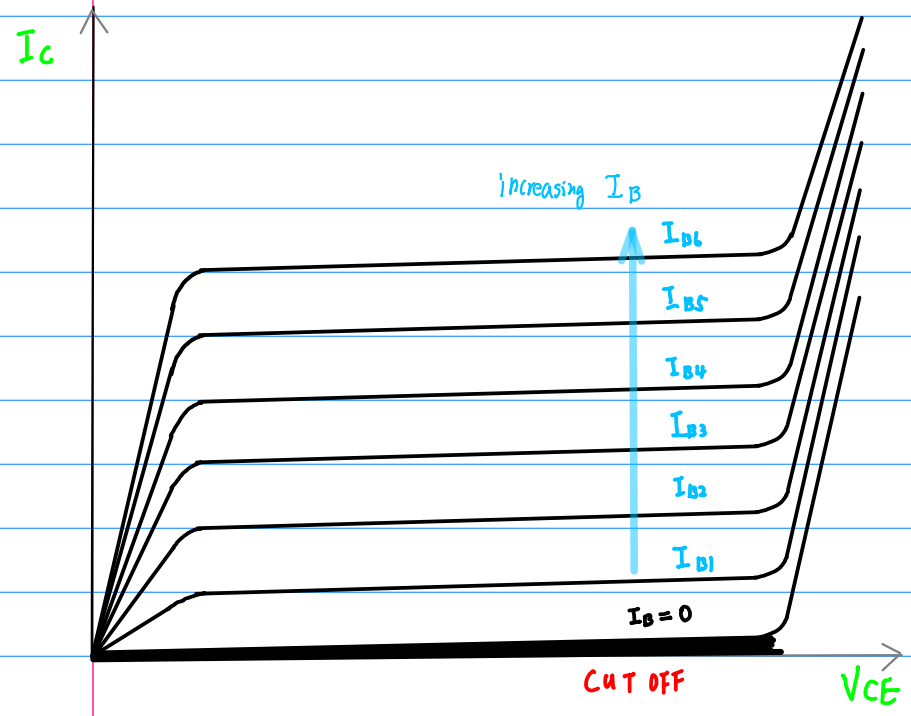
$$I_B = \frac{V_{BB} - V_{BE}}{R_B} \qquad I_C = \frac{V_{CC} - V_{CE}}{R_C} \qquad V_{CE} = V_{CC} - I_C R_C$$



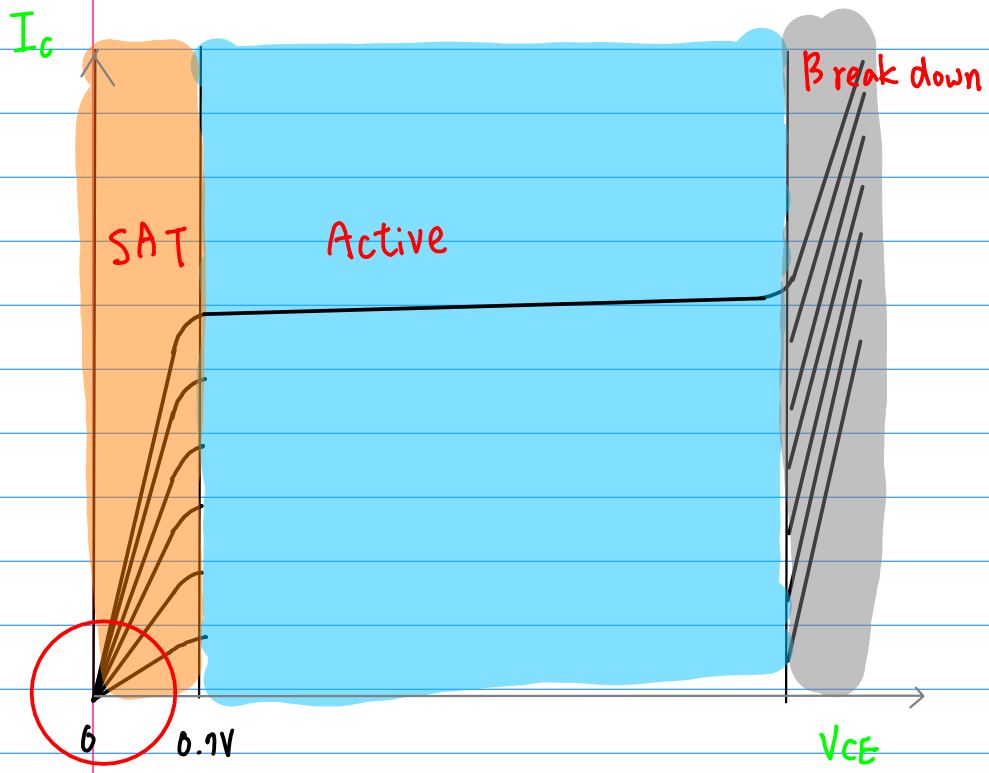


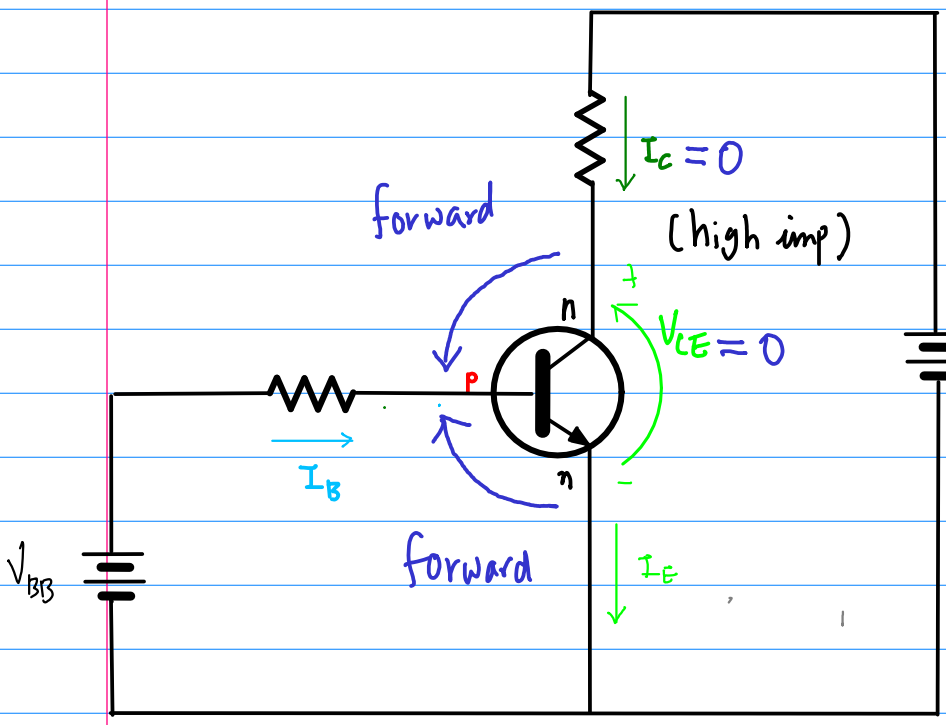
for a given I_B,
increase V_{cc} from 0


I_C
Break down
SAT
Active
0
0.7V
V_{CE}

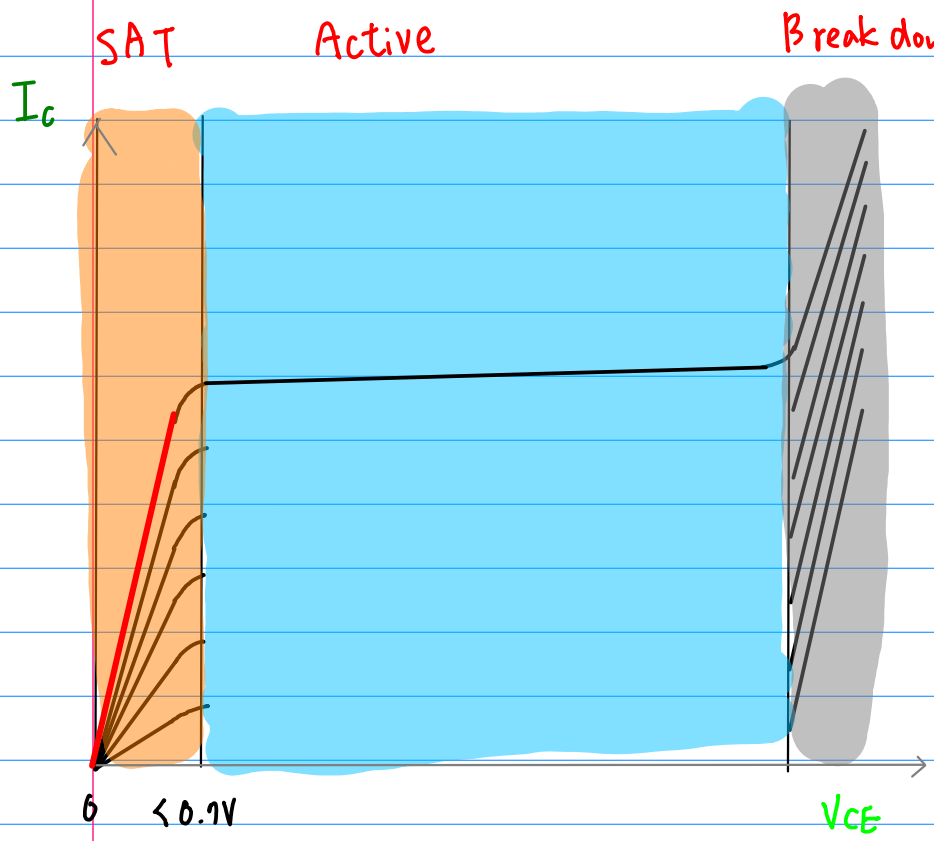

I_C
Increasing I_B
I_{B5}
I_{B4}
I_{B3}
I_{B2}
I_{B1}
$I_B = 0$
CUT OFF
V_{CE}

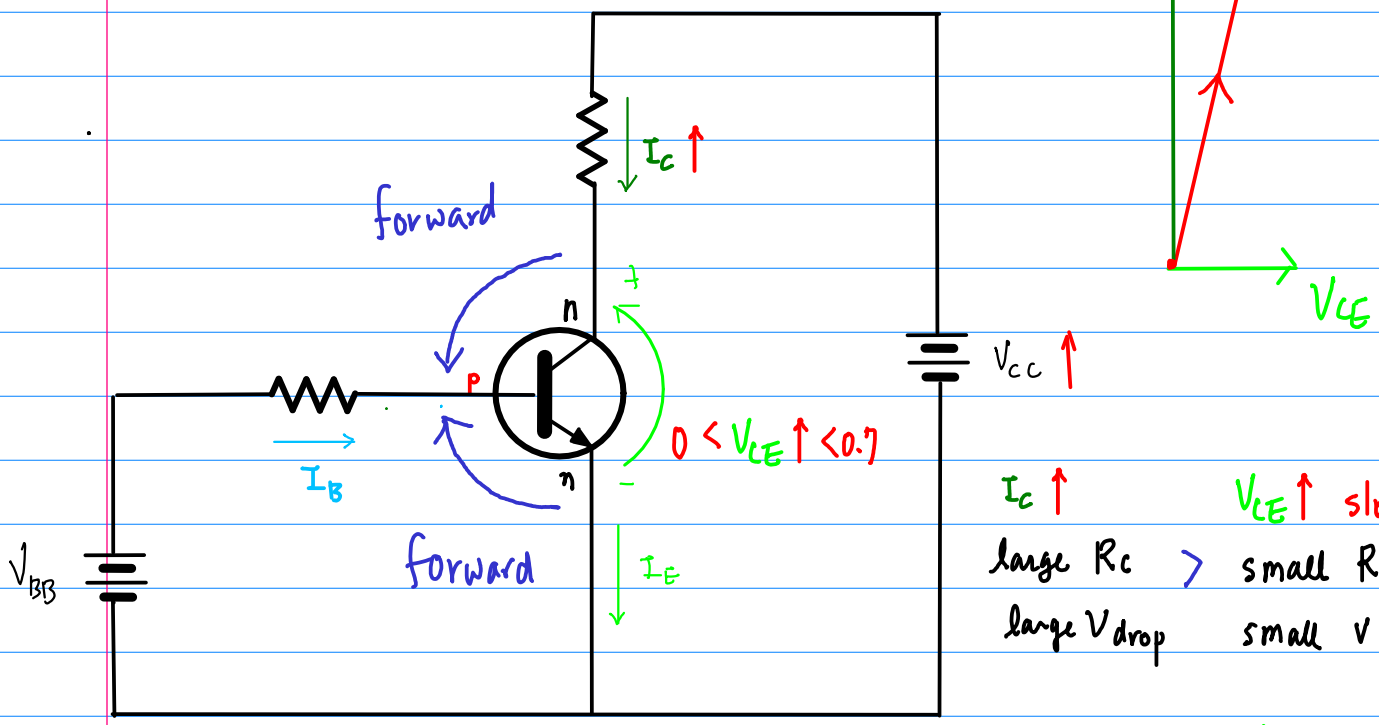
(A)





$$\left(R_E = 0, \quad R_C > 0 \right)$$
$$\left(I_B > 0, \quad I_C = 0 \right)$$

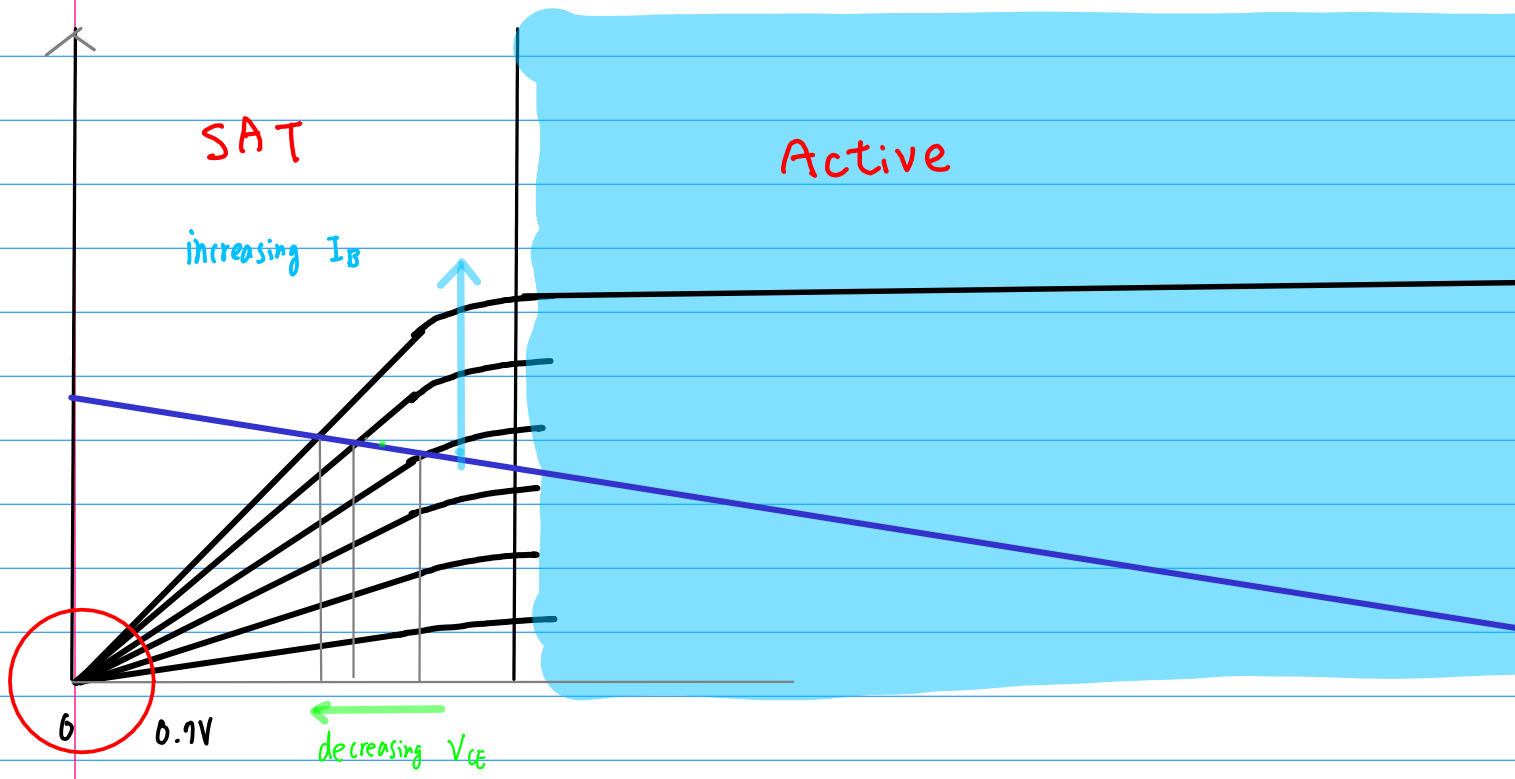




I_C ↑ large R_C > small R_{CE} large V_{drop} small V_{drop}

V_{CE} ↑ slowly

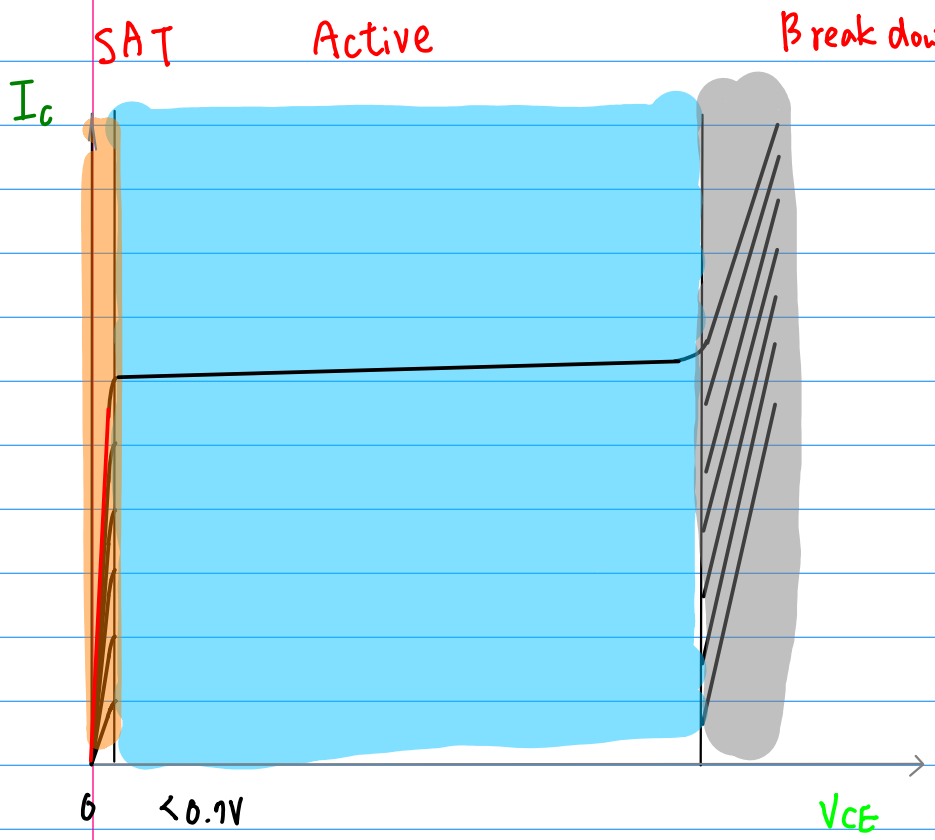
$V_{CE} < 0.7V$ for forward bias

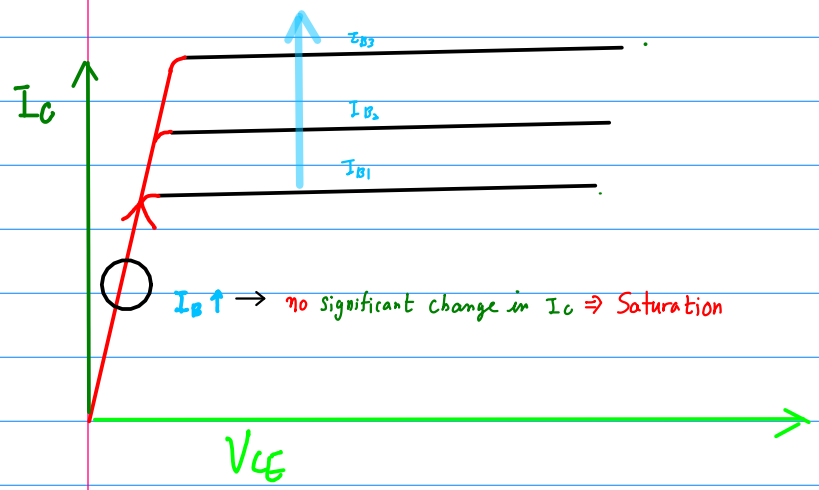


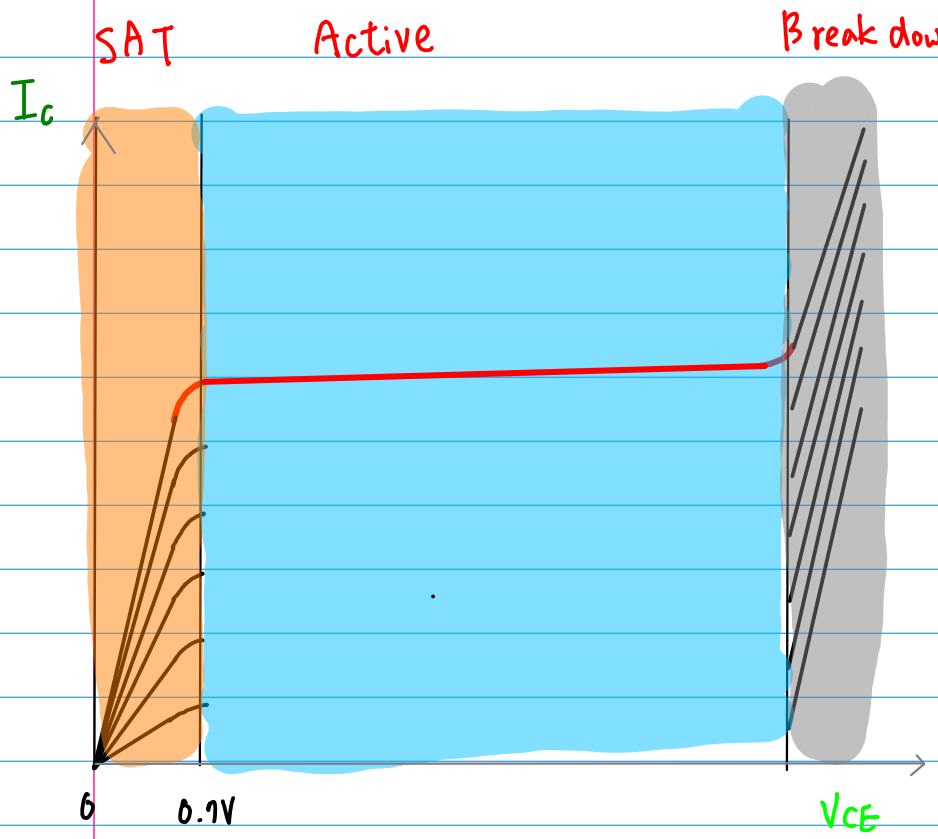
$I_B \uparrow \Rightarrow I_C \uparrow \Rightarrow$ more V_{drop} across R_C

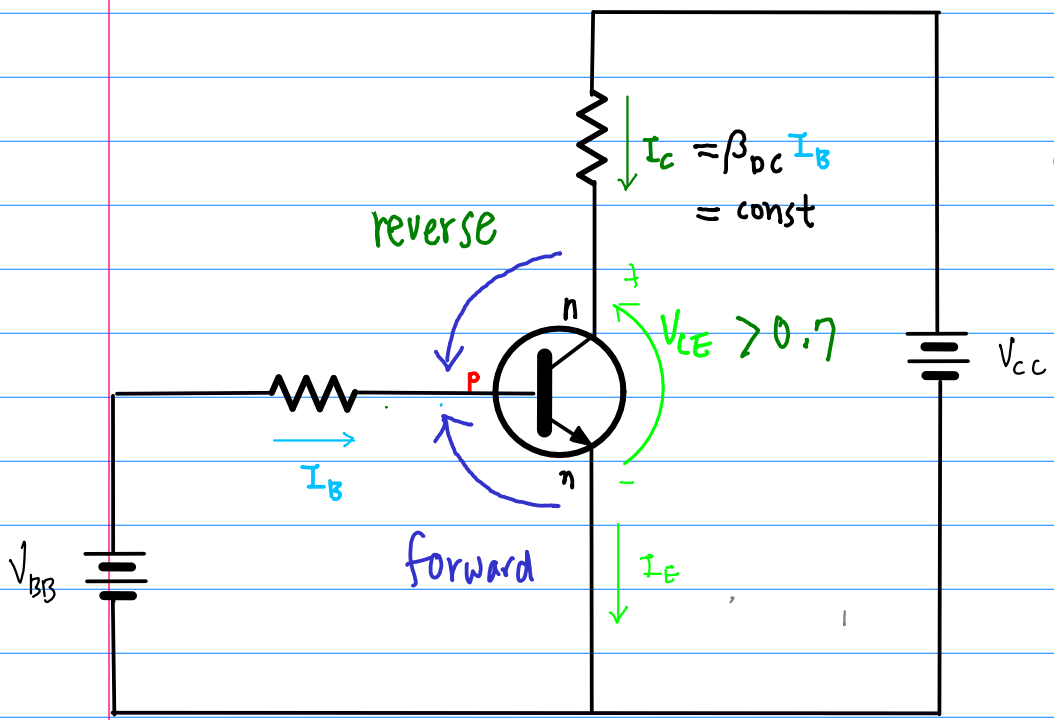
$\Rightarrow V_{CE} \downarrow$

difference not much.. $V_{CE} \cong 0.3\,V$


SAT
Active
Break down
I_C
0
< 0.7V
V_{CE}


I_C
I_{B3}
I_{B2}
I_{B1}
$I_B \uparrow \rightarrow$ no significant change in $I_C \Rightarrow$ Saturation
V_{CE}


SAT
Active
Break down
I_C
0
0.7V
V_{CE}


$I_C = \beta_{DC} I_B$
= const
reverse
n
P
n
$V_{CE} > 0.7$
V_{CC}
I_B
V_{BB}
forward
I_E

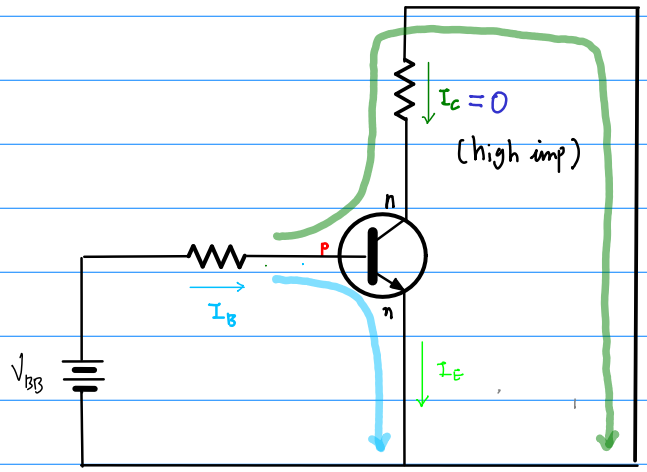
$$V_{CE} + V_{R_C} = V_{CC}$$

(A) $V_{cc} \approx 0$

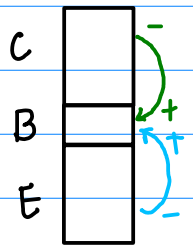
2 paths

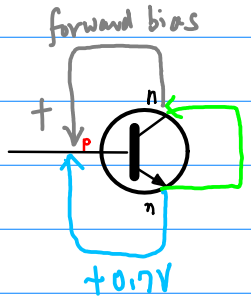
B → E

B → C (Rc) → $I_c = 0$

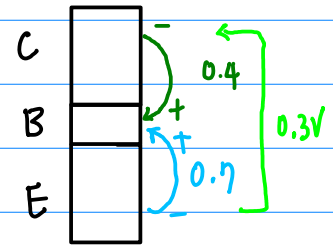


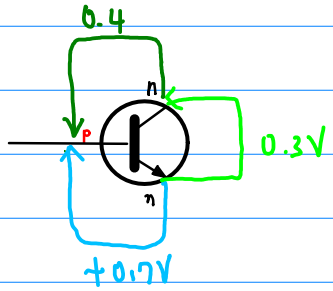
(A)–(B)

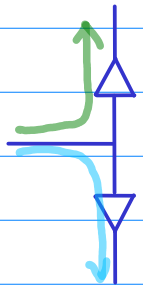


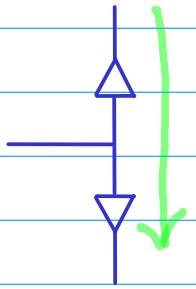


$\leq 0.7V$ for saturation

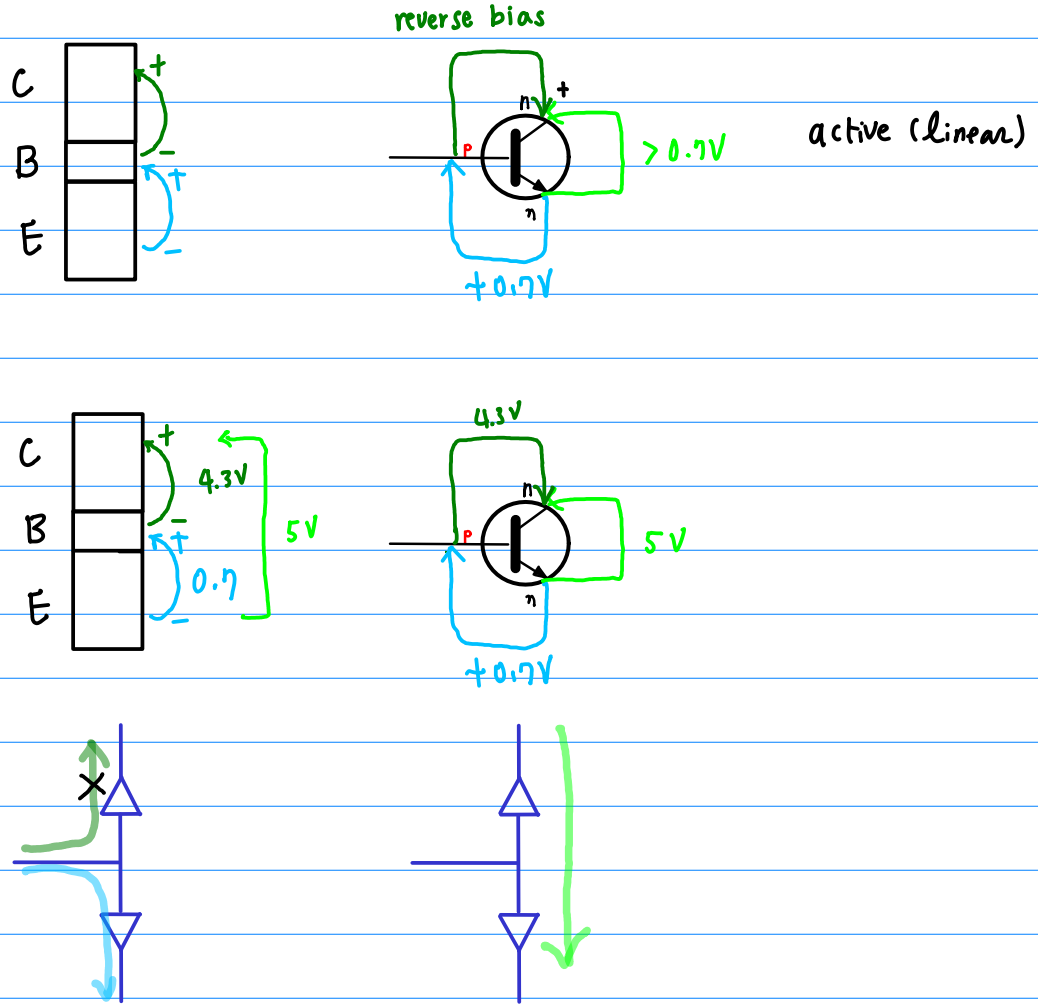


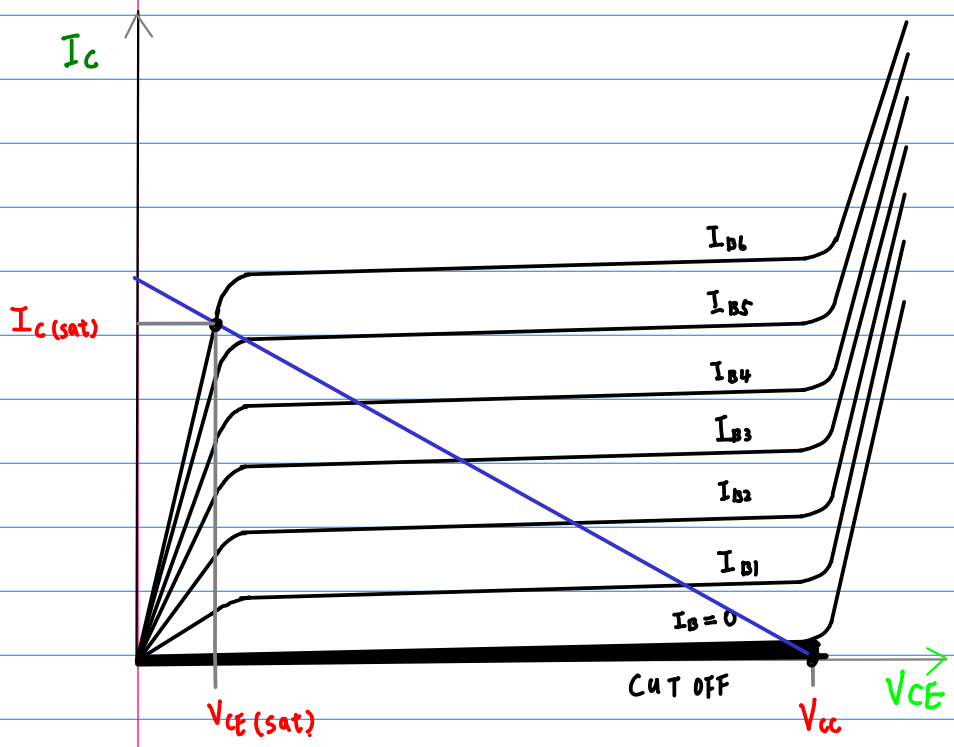




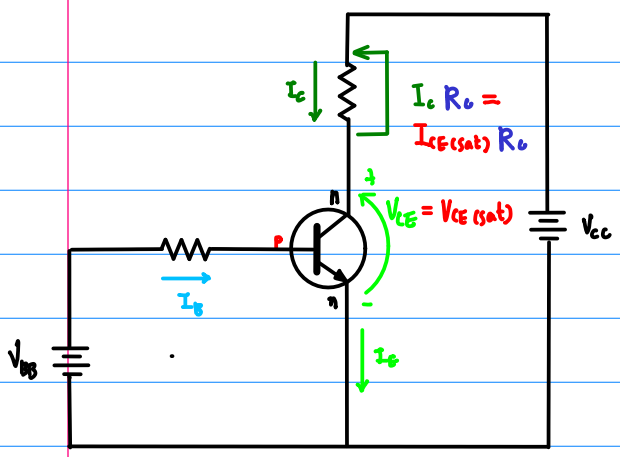


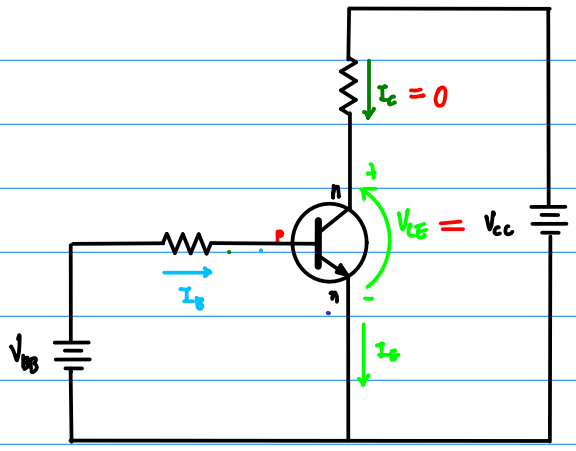
(B) – (C) Active (Linear)

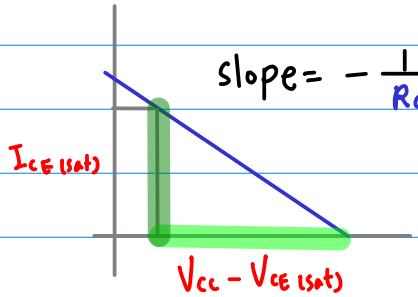


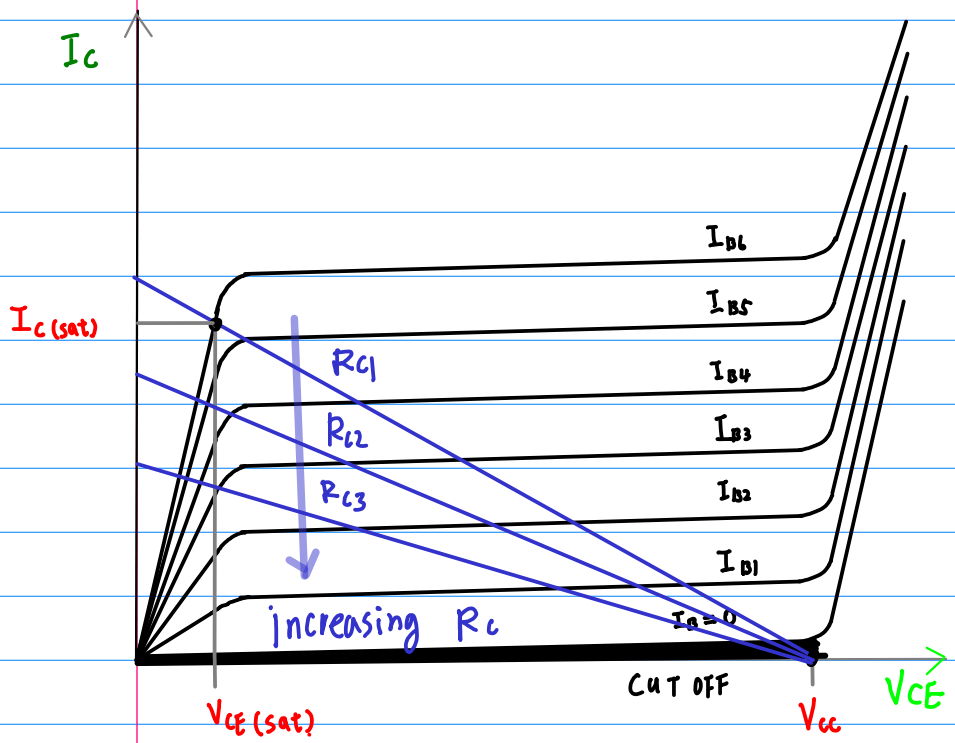


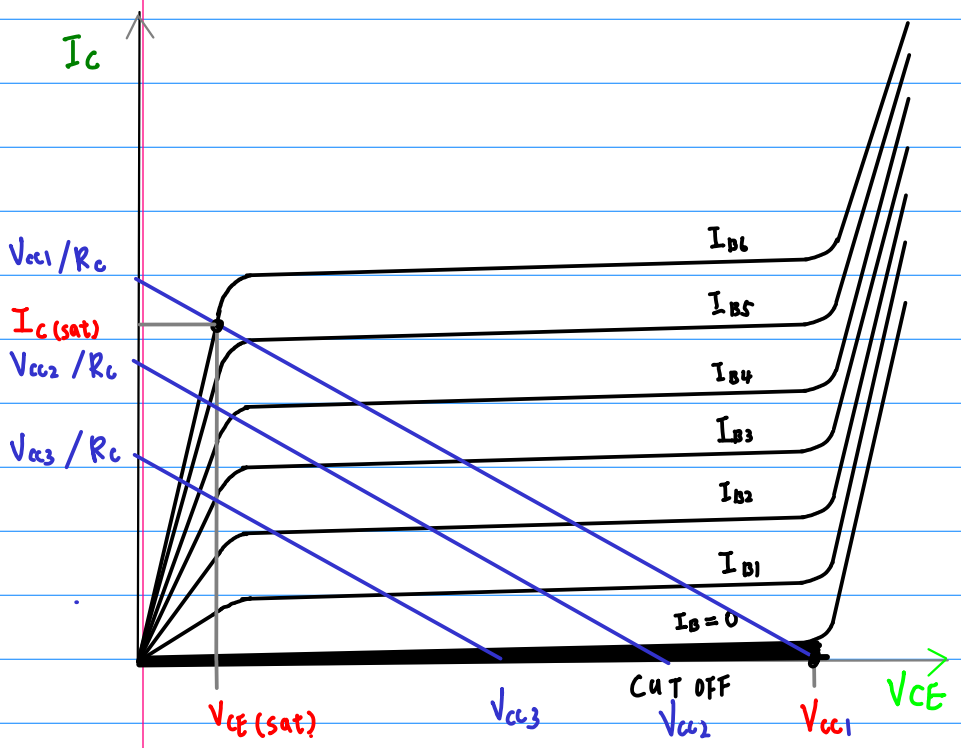
$$V_{CC} - V_{CE(sat)} = I_{CE(sat)} R_C$$








I_C
$I_{C(sat)}$
I_{B6}
I_{B5}
I_{B4}
I_{B3}
I_{B2}
I_{B1}
$I_B = 0$
R_{C1}
R_{C2}
R_{C3}
increasing R_C
CUT OFF
$V_{CE(sat)}$
V_{CC}
V_{CE}


I_C
V_{CC1}/R_C
$I_{C(sat)}$
V_{CC2}/R_C
V_{CC3}/R_C
I_{B6}
I_{B5}
I_{B4}
I_{B3}
I_{B2}
I_{B1}
$I_B = 0$
CUT OFF
$V_{CE(sat)}$
V_{CC3}
V_{CC2}
V_{CC1}
V_{CE}