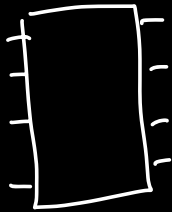Transistor - Transistor logic
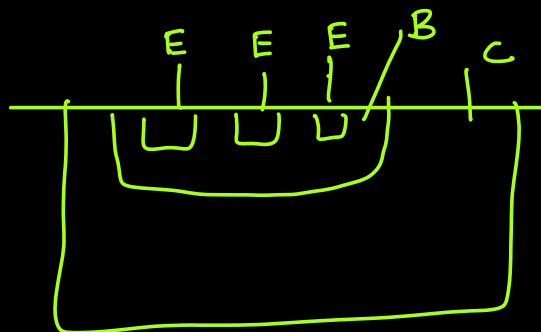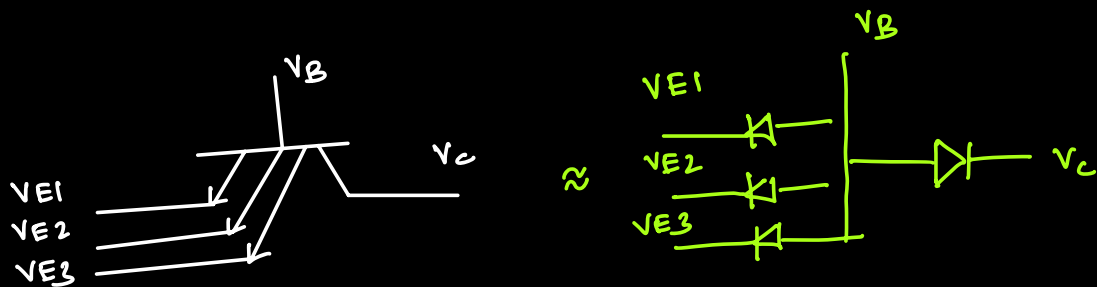
BJT
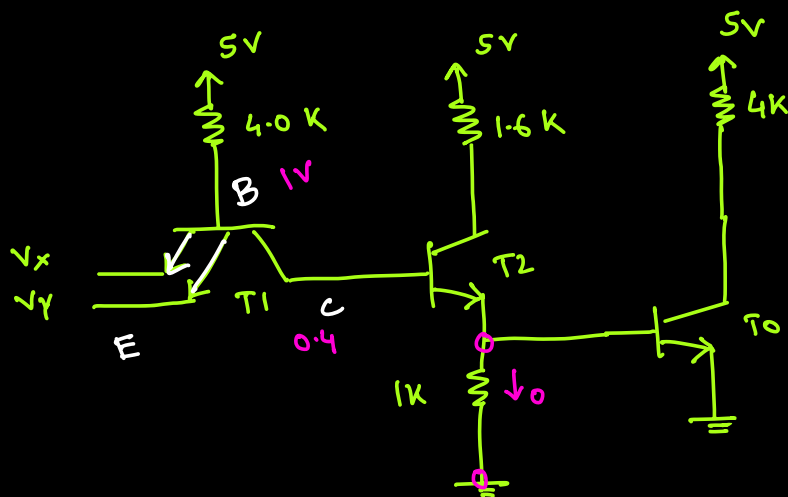
Bipolar → saturated

Faster switching compared to DTL

74 - Ic   TTL circuit

Multi emitter Transistor

V_B

V_{E1}
V_{E2}
V_{E3}

V_c

$\approx$

V_{E1}
V_{E2}
V_{E3}

V_B

V_c

E   E   E   B   C

5V

5V

5V

4.0 K

1.6 K

4K

B 1V

T2

Vx

Vy

T1   C
0.4

E

1K $\downarrow_0$

T0

V_0

0

0

case 1

$$V_x \; V_y \;\; = \; 0.2 v$$
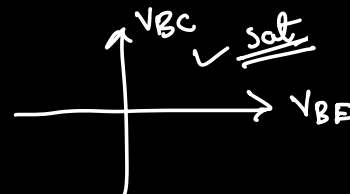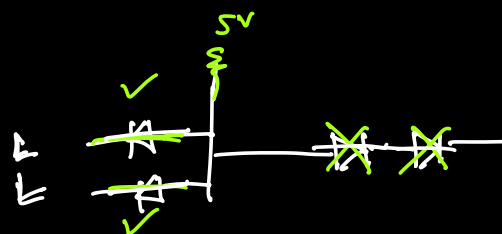
assume   BC & BE
junction   of T1 $\longrightarrow$ forward biased

(saturation)

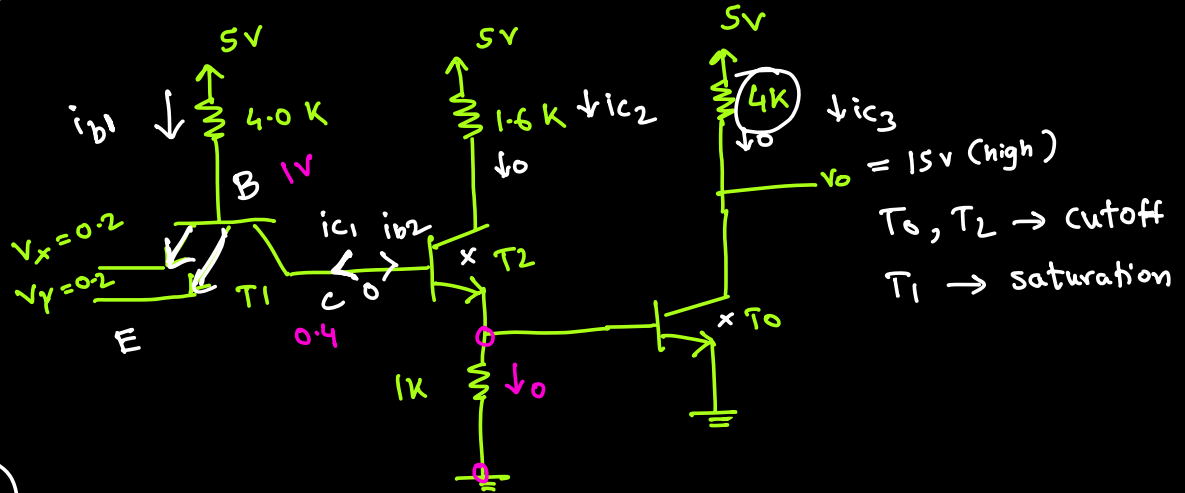① $V_{CE} = 0.2 v$ $V_{E1} = 0.2 v$

② $V_{BE} = 0.8 v$ $V_{E2} = 0.2 v$

$V_{CE} = V_c - V_E = 0.2$

$V_c = 0.2 + 0.2 = 0.4 v$

$V_B = 0.8 + 0.2 = 1 v$

V_{BC} Sat

V_{BE}

$\beta_F = 30$

5V

$i_{b1} \downarrow$ ⎰ 4.0 K

B 1V

$V_x = 0.2$

$V_Y = 0.2$

E   T1

ici ib2

c 0

0.4

1K $\downarrow V_0$

0

5V

⎰ 1.6 K $\downarrow ic_2$

$\downarrow 0$

x T2

0

5V

⎰ (4K) $\downarrow ic_3$

$\downarrow 0$

$V_0 = 15v$ (high)

$T_0, T_2 \rightarrow$ cutoff

$T_1 \rightarrow$ saturation

x T0

(T1)

$i_{b1} = \dfrac{5-1}{4k} = 1mA$ //

$ic_1 = 0$

$i_{E1} = i_{Ex} + i_{EY} = \overset{0}{\underset{\uparrow}{i_{c1}}} + \overset{1mA}{\underset{\uparrow}{i_{b1}}}$

$i_{E1} = 1mA$

$i_{Ex} = i_{EY} = 0.5mA$

$\beta_{forced1} = \dfrac{ic_1}{i_{b1}} = \dfrac{0}{1} = 0 \quad < \beta_{FWD}$
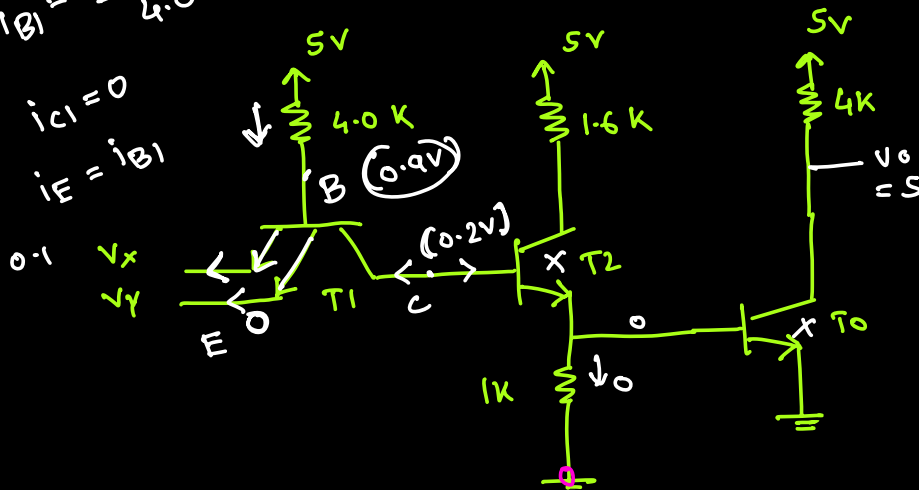
$ic_1 = -ib_2$

$ic_1 = -0 = 0$

$$i_{B1} = \frac{5 - 0.9}{4.0 K}$$

$\overline{i_{EY} = 0}$ $\therefore i_{EX} = i_E$

$V_{BE} = 0.8$

$V_{CE} = 0.1$

$i_{C1} = 0$

T1

$i_E = i_{B1}$

$\boxed{V_{E1} = 0.1}$

5V

4.0 K

B (0.9V)

5V

1.6 K

5V

4K

$V_B = 0.1 + 0.8$

0.1 V_x

[0.2V]

X T2

$V_0 = S$

$V_C = 0.1 + 0.1$

V_Y

T1

C

E O

O

i_0

1K

$\times$ T0

O

i_0

1K

O

$V_x = 0.1 V$

$V_Y = 5 V$

fwd bias   fwd bias

0.1 ← E_1 C

B

5   E_2

→ Reverse bias

V_{BC}

sat.

→ V_{BE}

on

L

H

off

Sat.

case ③

$\beta_{FWD} = 25$

$\beta_{R.A} = 0.1$

$B = ic \over iR$

$V_{CEO} = 0.1v$

$V_{BEO} = 0.8V$

$V_O = 0.1$ ✓

$VEO = 0$ ✓

$V_{CE2} = 0.1$

$V_{C2} - VE_2 = 0.1$

$V_{C2} = 0.1 + 0.8 = 0.9v$

$i_{CO} = \dfrac{5 - 0.1}{4K} = 1.23 mA$

$i_{C2} = \dfrac{5 - 0.9}{1.6K} = 2.56 mA$
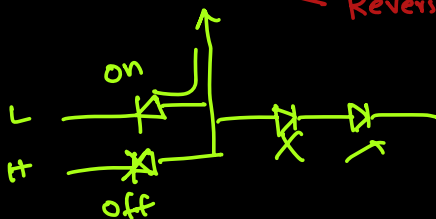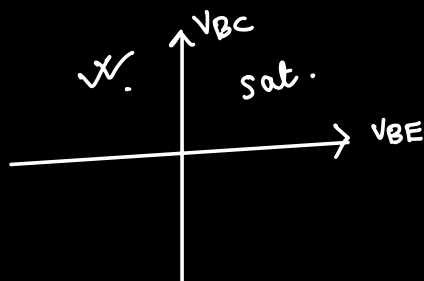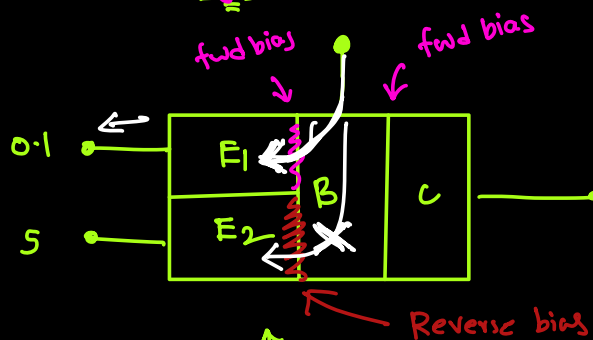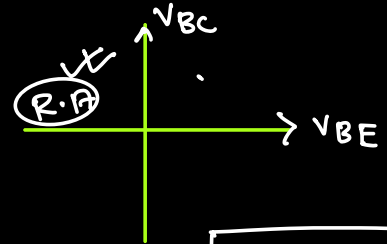
$V_{BC} = 0.7$

$V_C = 1.6$

$V_B - V_C = 0.7$

$V_B = 0.7 + 1.6$

$= 2.3$

$i_{b1} = \dfrac{5 - 2.3}{4.0K} = 0.675 mA$

$\dfrac{0.8 - 0}{1K} = 0.8 mA$

$(T1)$

$i_{b1} = 0.67mA$

$0.1 = \dfrac{i_{E1}}{i_{b1}} = \dfrac{i_{E1}}{0.67}$

$\beta_{rev} = \dfrac{I_E}{I_B}$

$i_{E1} = 0.1 \times 0.675 mA$

$i_{E1} = 0.0675 mA$

$i_{c1} = i_{Ex} + i_{EY} + i_{B1}$

$i_{Ex} = i_{EY} = 0.0675 mA$

$= 0.0675$
$+ 0.0675 + 0.67$

$i_{c1} = 0.81 mA$

$(T2)$

$i_{c1} = \boxed{i_{b2}} = 0.81 mA$

$\beta_{forced} \rightarrow ?$

$\boxed{i_{c2}} = \dfrac{5 - 0.9}{1.6K} = 2.56mA$

$\beta_{forced} = \dfrac{2.56}{0.81} = <25$

$i_{E2} = i_{b2} + i_{c2} = \boxed{0.81 + 2.56 mA}$

$(T0)$

$i_{E2} = i_{b0} + i_1$

$i_{co} = \dfrac{5 - 0.1}{4K} = 1.23mA$

$i_{bo} = i_{E2} - i_1$

$\beta_{forced} = \dfrac{1.23}{i_{bo}}$

$= (0.81$
$+ 2.56) - 0.8 \ mA$

$= < 25$

$= 2.56$