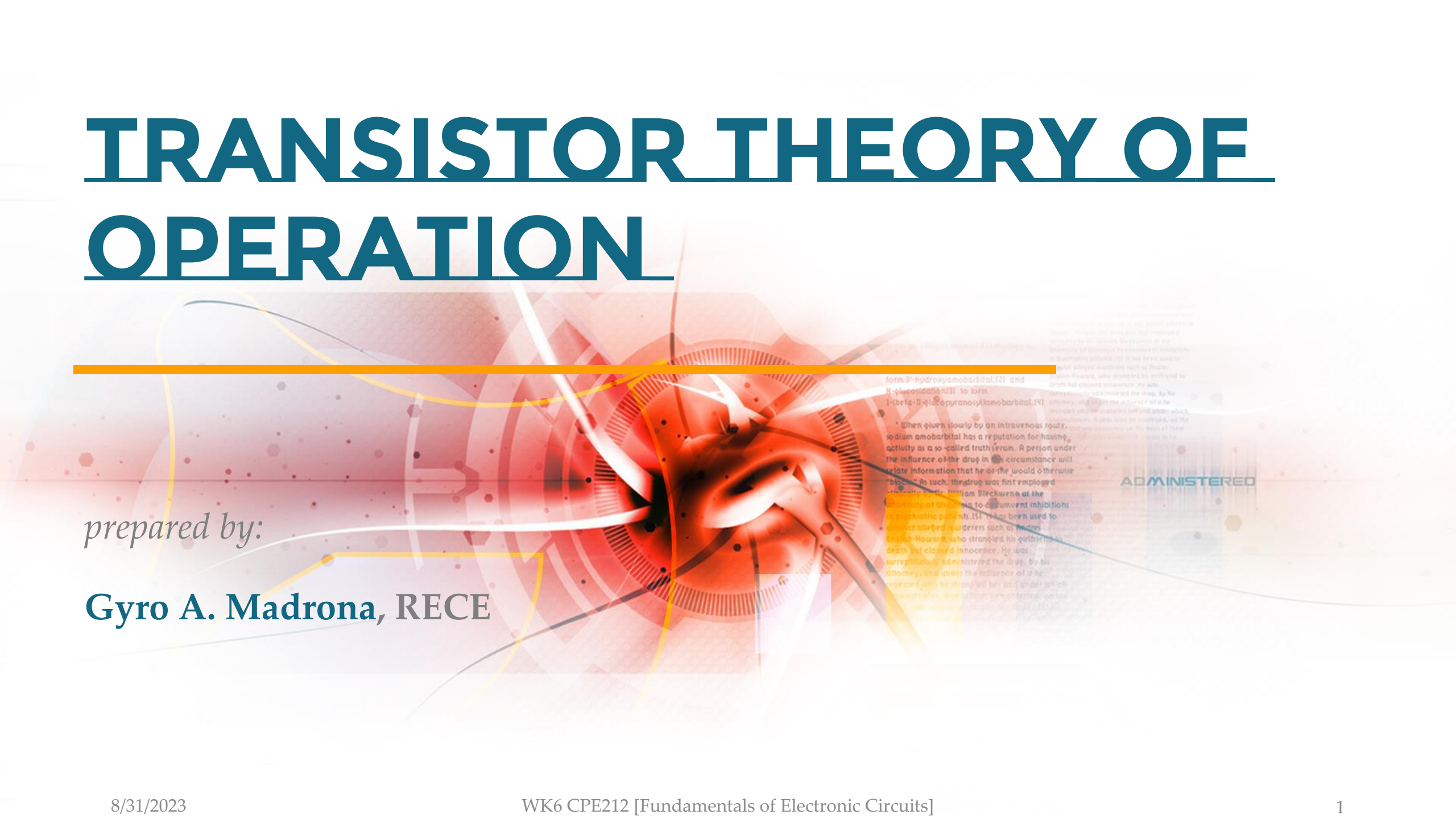
TRANSISTOR THEORY OF OPERATION



prepared by:

Gyro A. Madrona, RECE

GRADING SYSTEM

30%

PRELIM

30%

MIDTERM

40%

ENDTERM

50%

WEEKLY

50%

EXAM

100%

LABORTORY

0

ABSENT

3

45-min LATE

7 max

15-min LATE

TOPIC OUTLINE

Transistor Construction and Operation

Transistor Configurations

- Common Base
- Common Collector
- Common Emitter

Characteristic Curve

Regions of Operation

Reading Datasheet

TRANSISTOR CONSTRUCTION AND OPERATION

THE FIRST TRANSISTOR

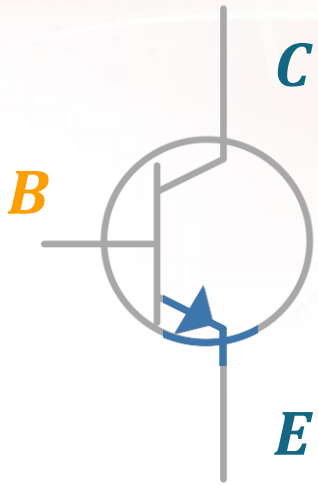
December 23, 1947

Dr. William Shockley

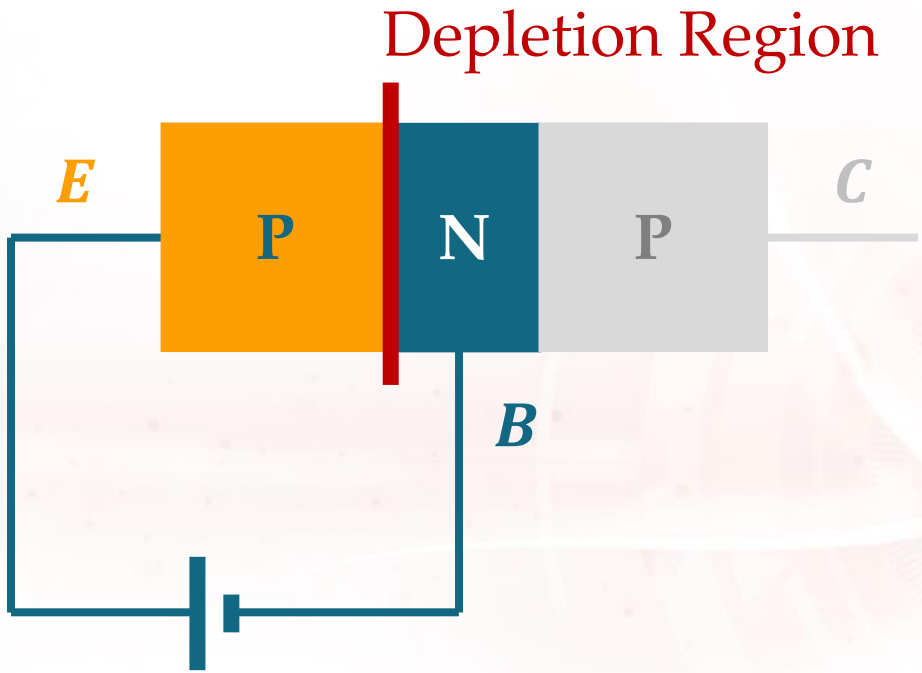
Dr. John Bardeen

Dr. Walter Brattain

NPN



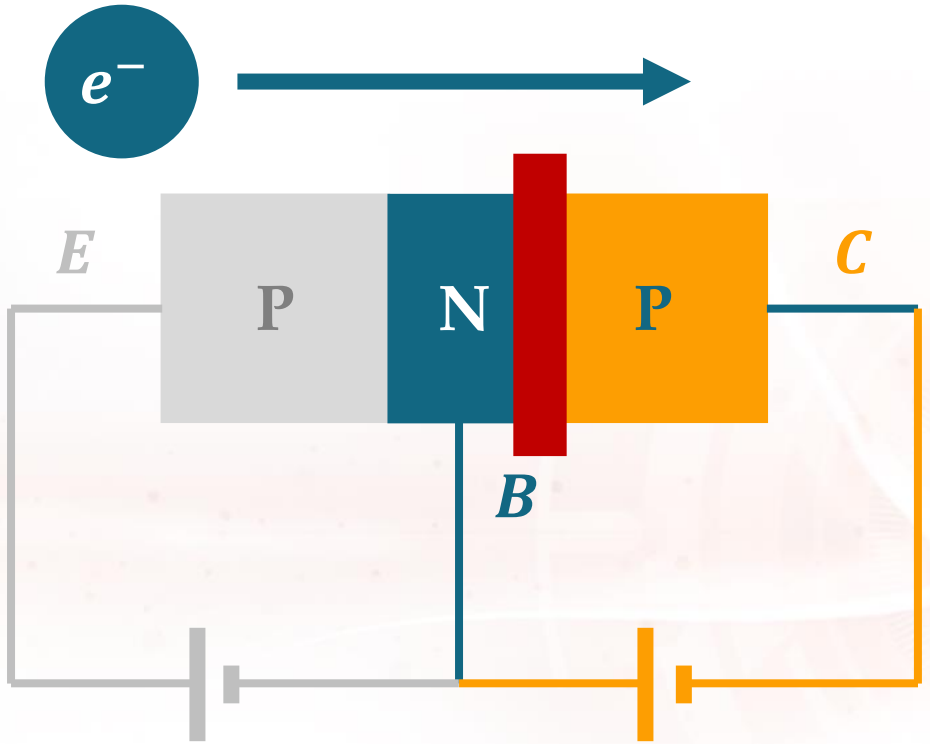
PNP



forward-biased

Emitter is **heavily** doped

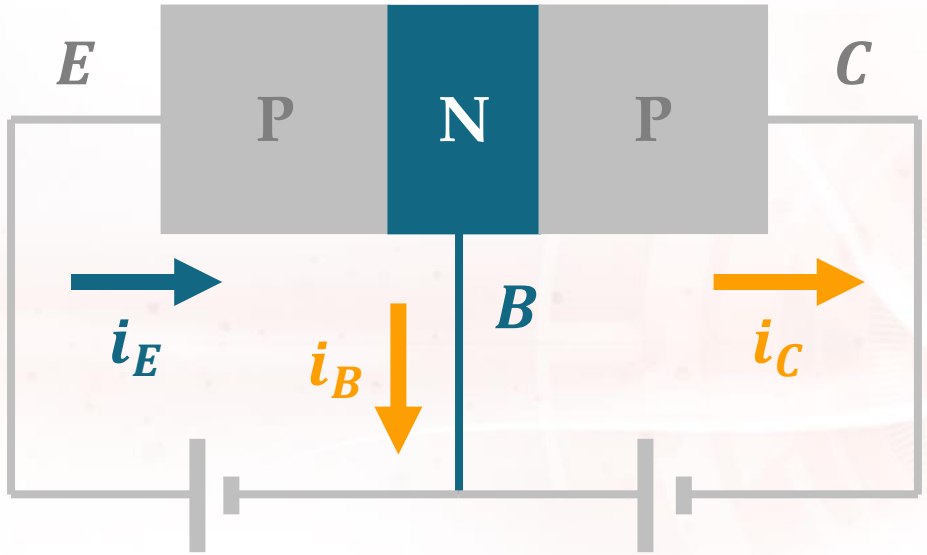
Base is **lightly** doped



reverse-biased

Collector is "**intermediate**" doped

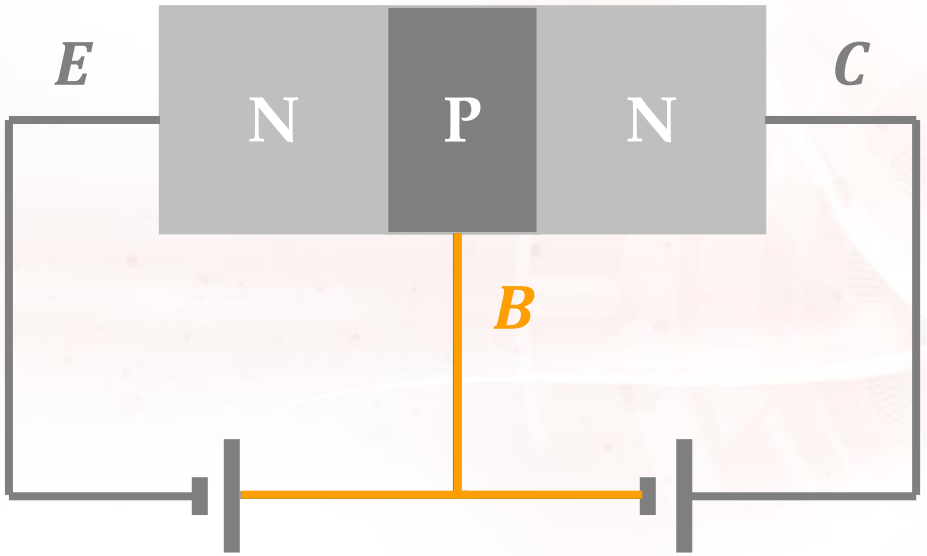
KCL @ B,

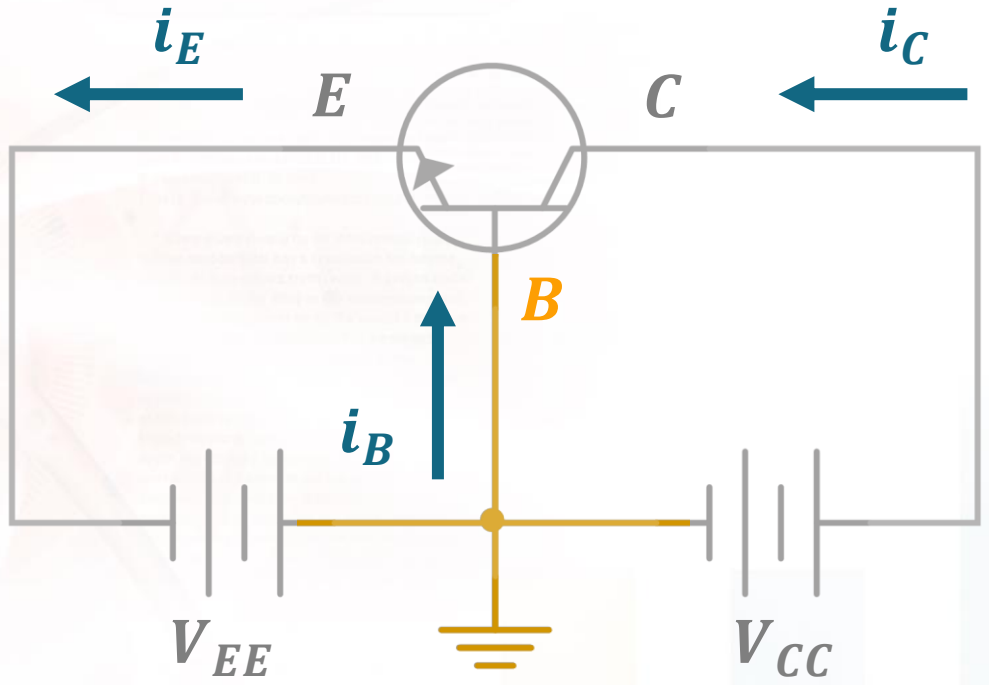


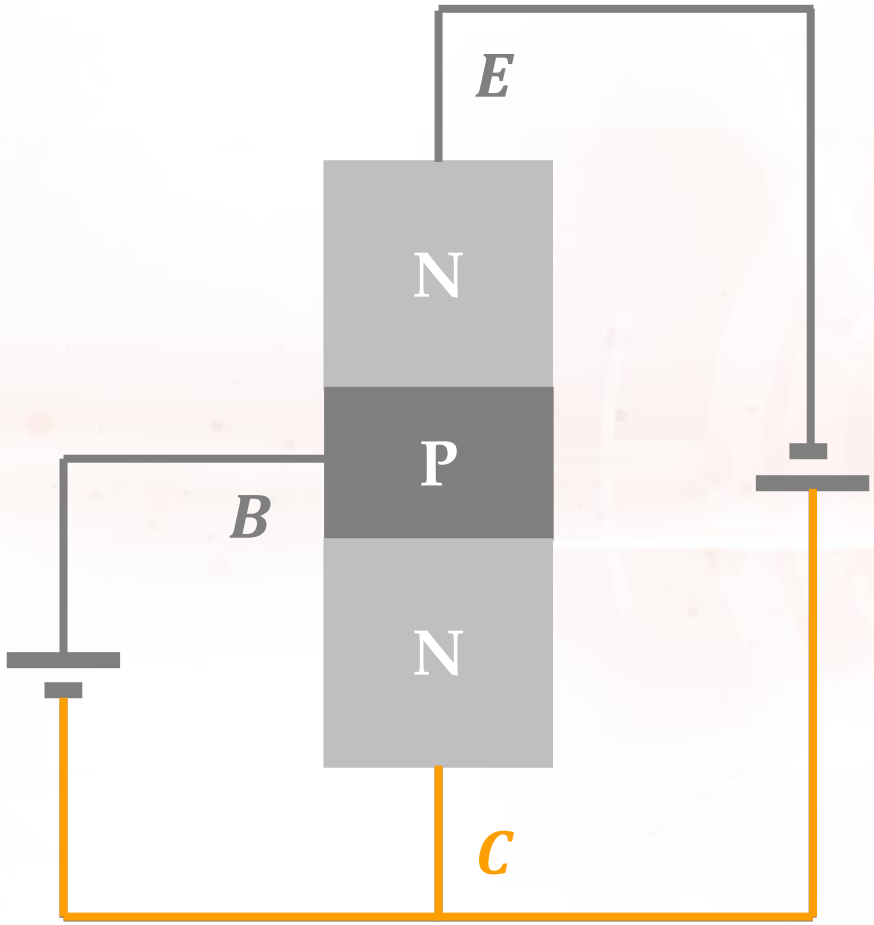
$$i_E = i_C + i_B$$

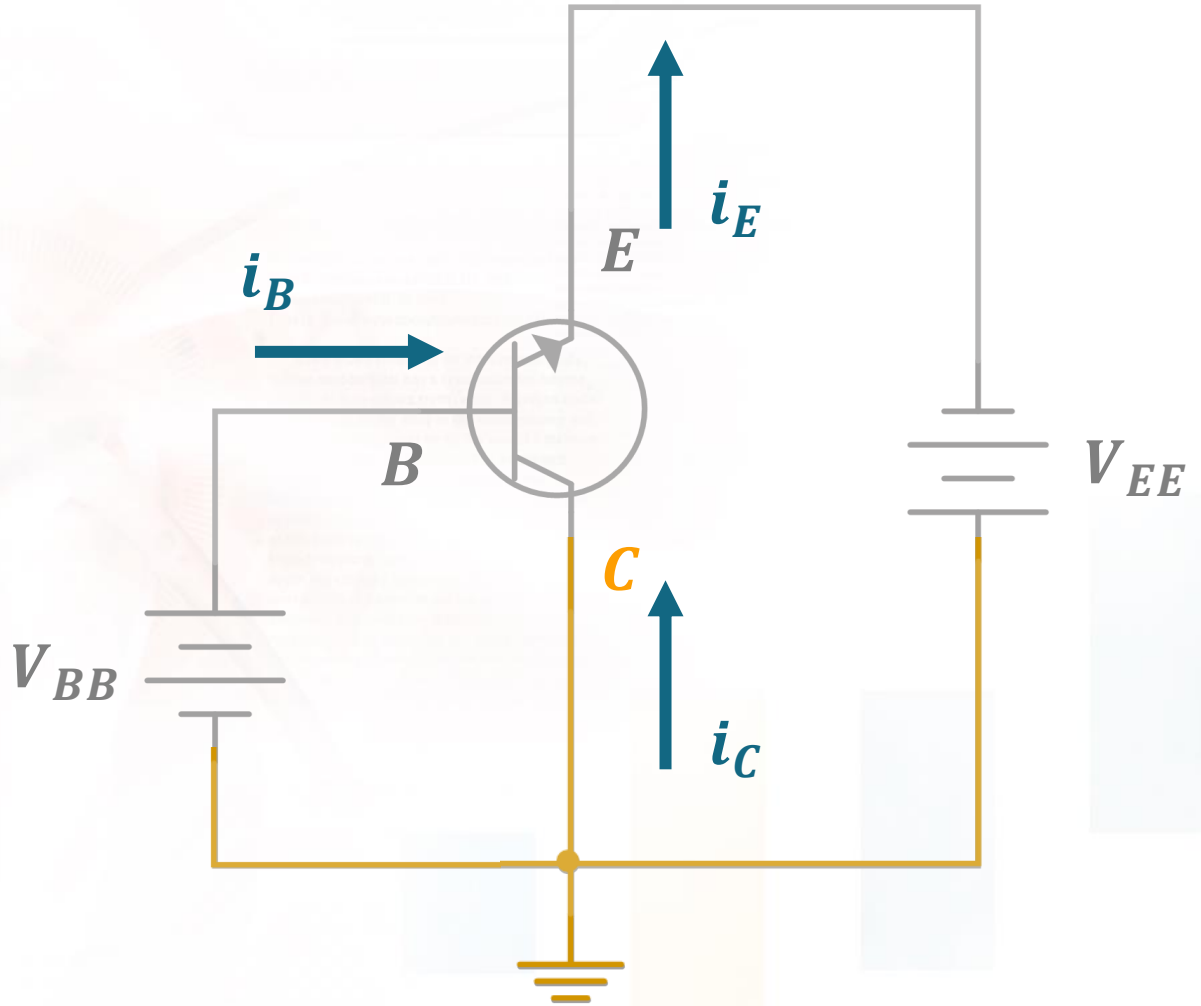
TRANSISTOR_

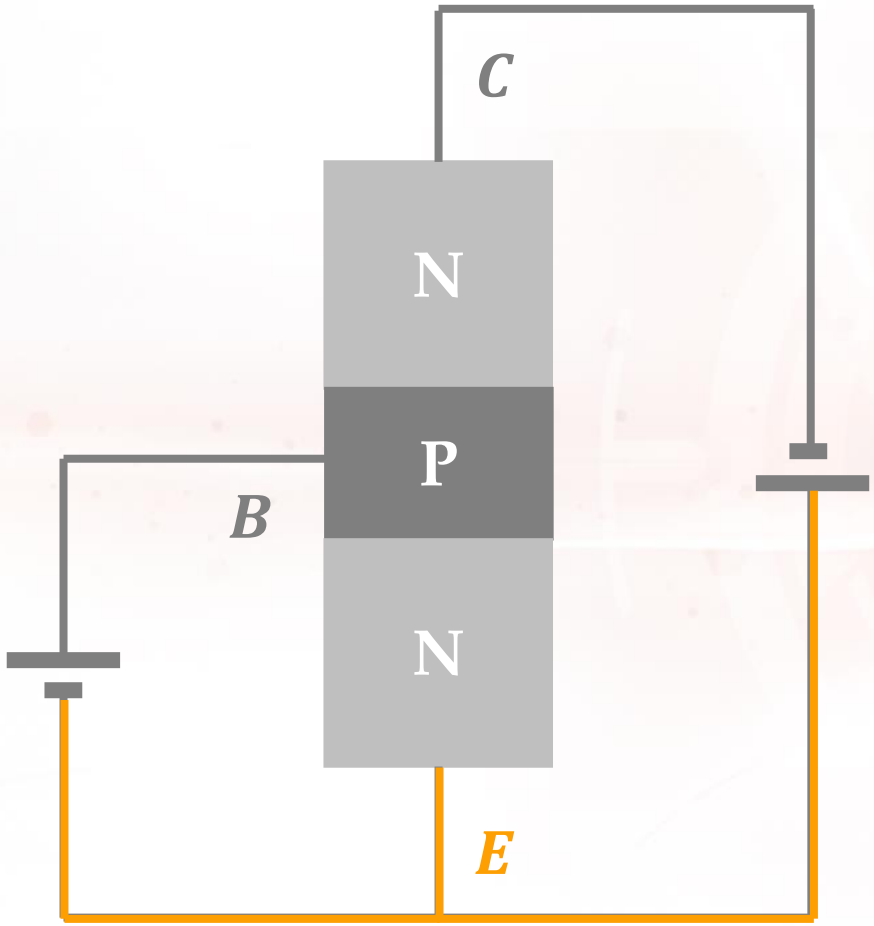
CONFIGURATIONS_

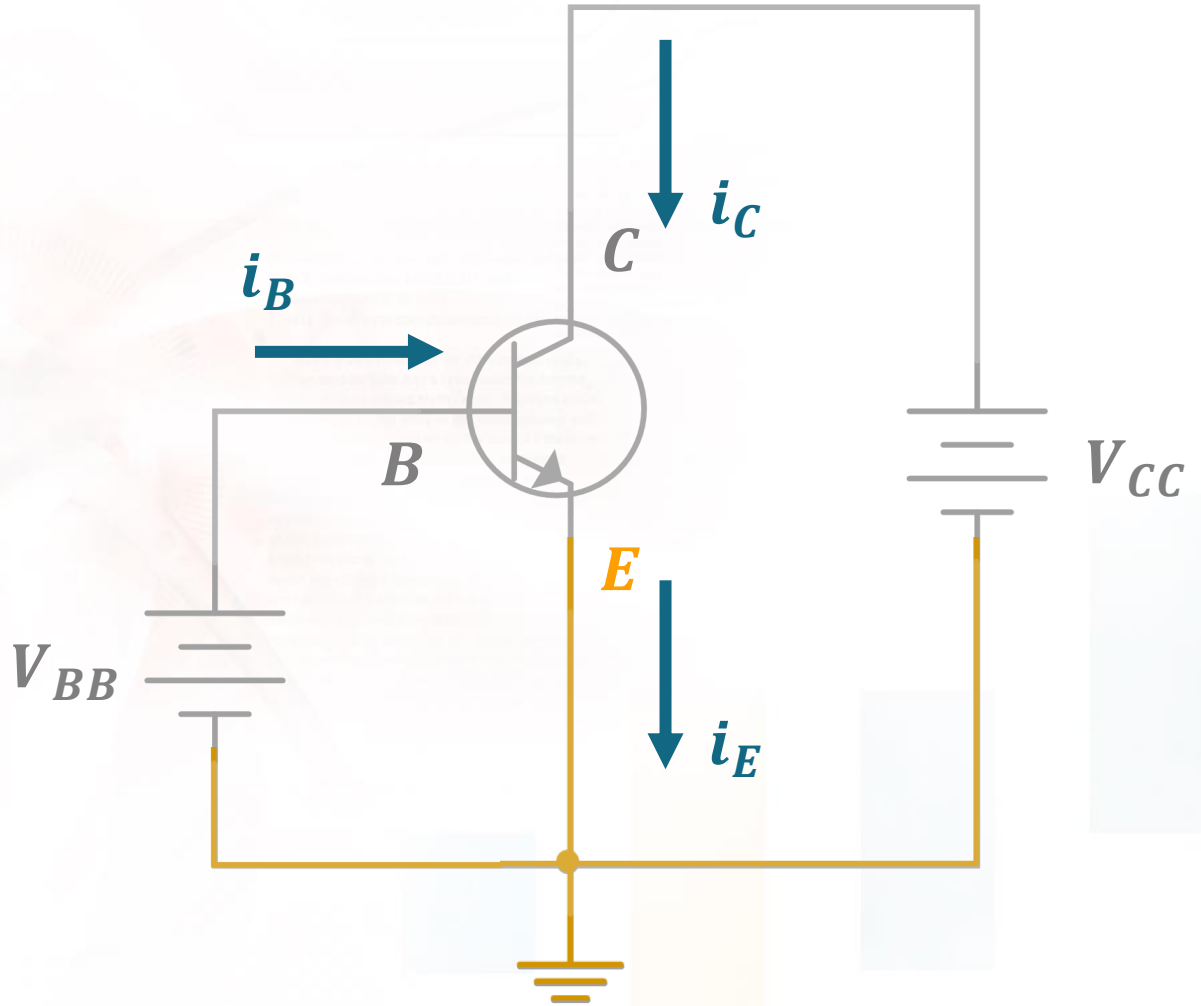

E
N
P
N
C
B


i_E
E
C
i_C
B
i_B
V_{EE}
V_{CC}

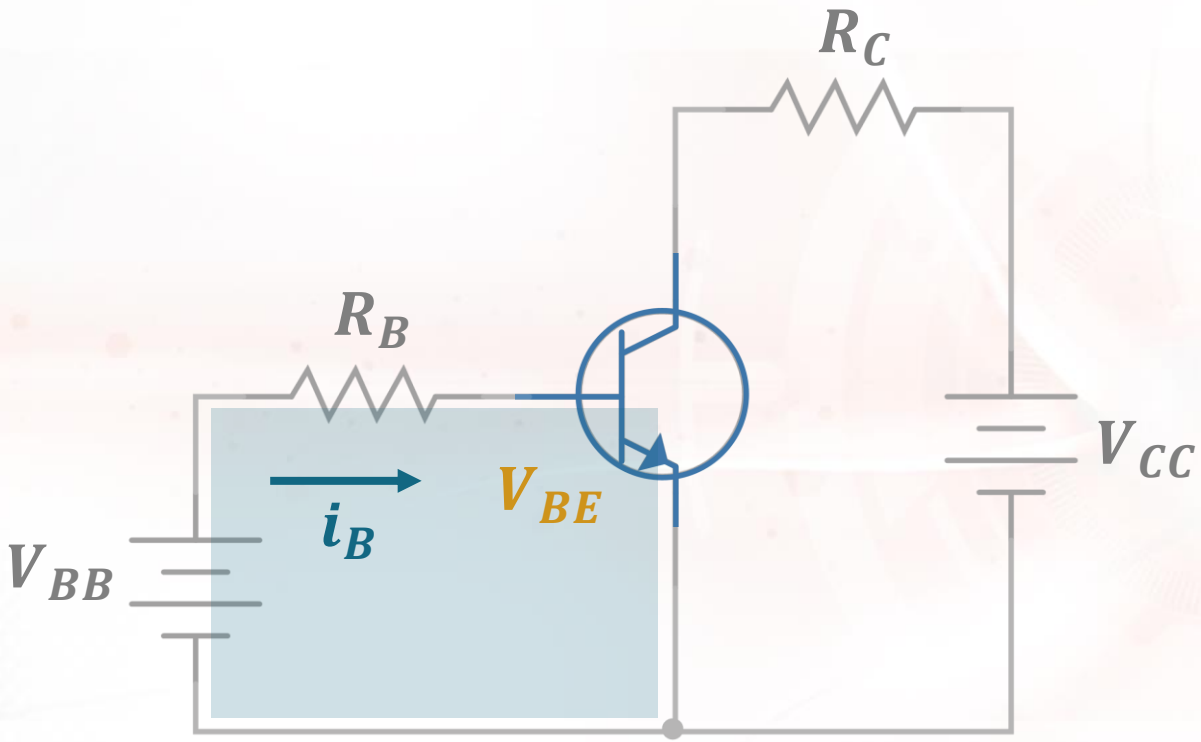

E
N
P
B
N
C

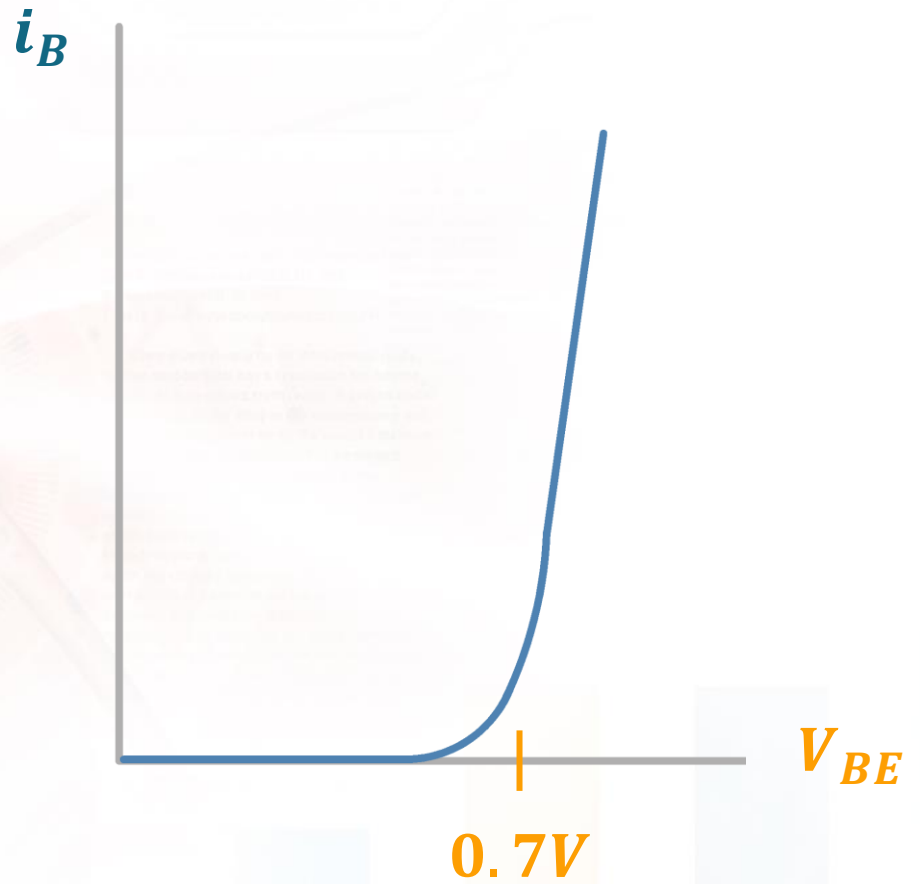

i_B
E
i_E
B
V_{EE}
C
V_{BB}
i_C


C
N
P
B
N
E

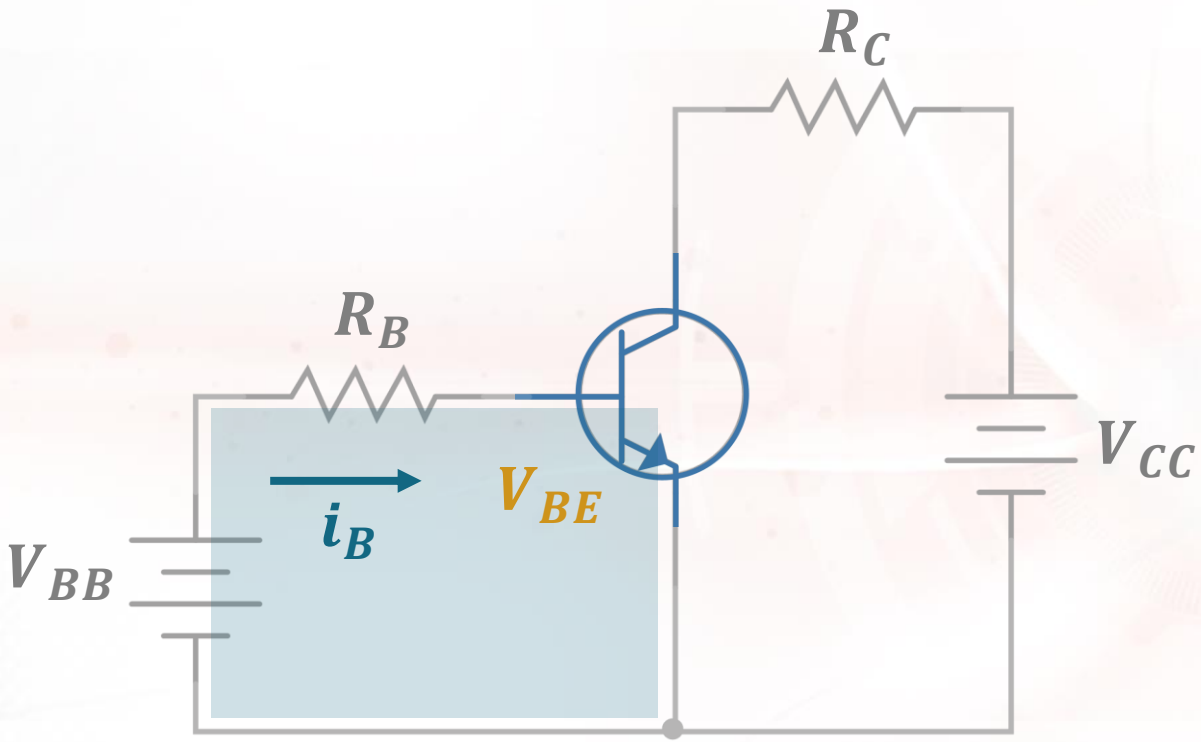

i_C
C
i_B
B
V_{CC}
E
V_{BB}
i_E

CHARACTERISTIC CURVE

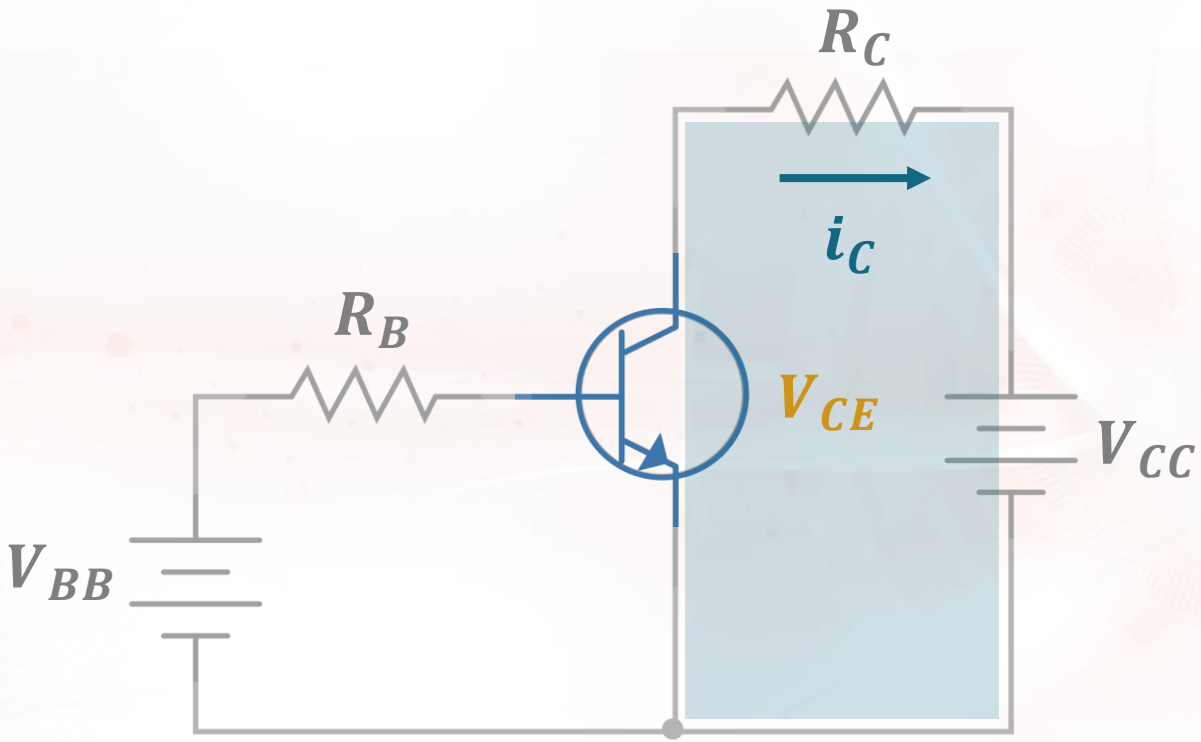

R_C
R_B
V_{CC}
V_{BE}
i_B
V_{BB}

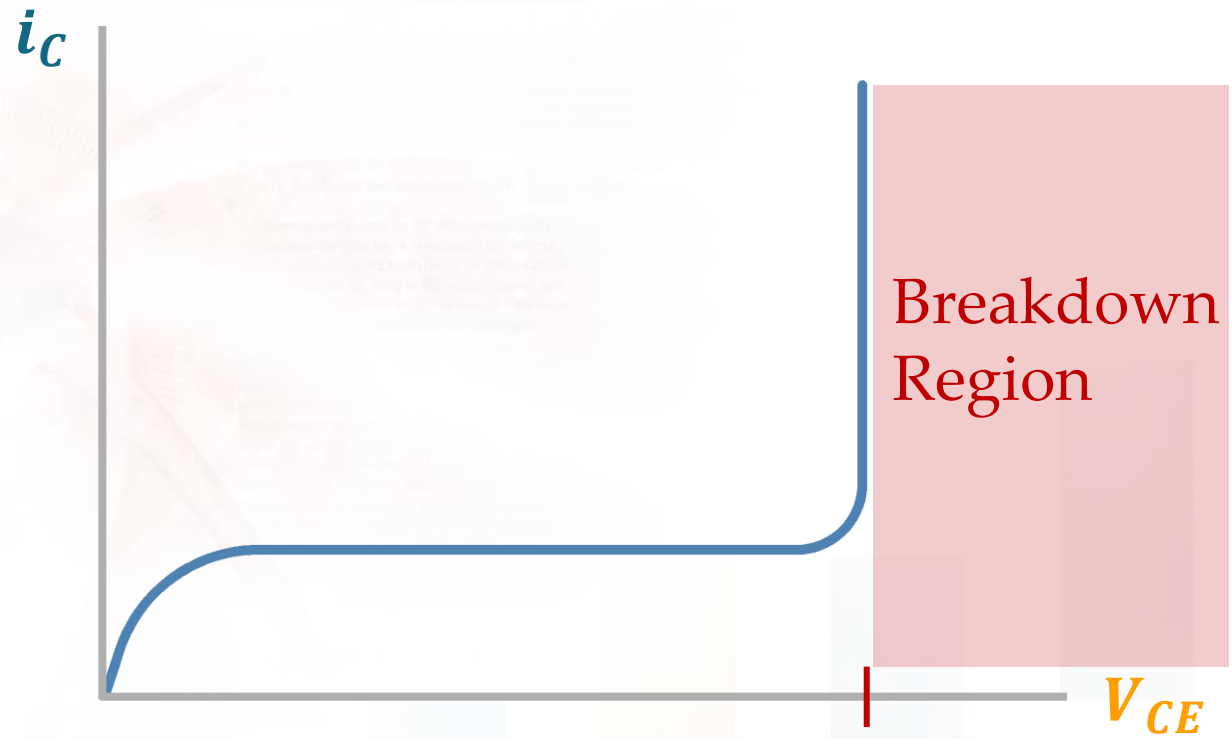

i_B
V_{BE}
$0.7V$

Base-Emitter Loop,

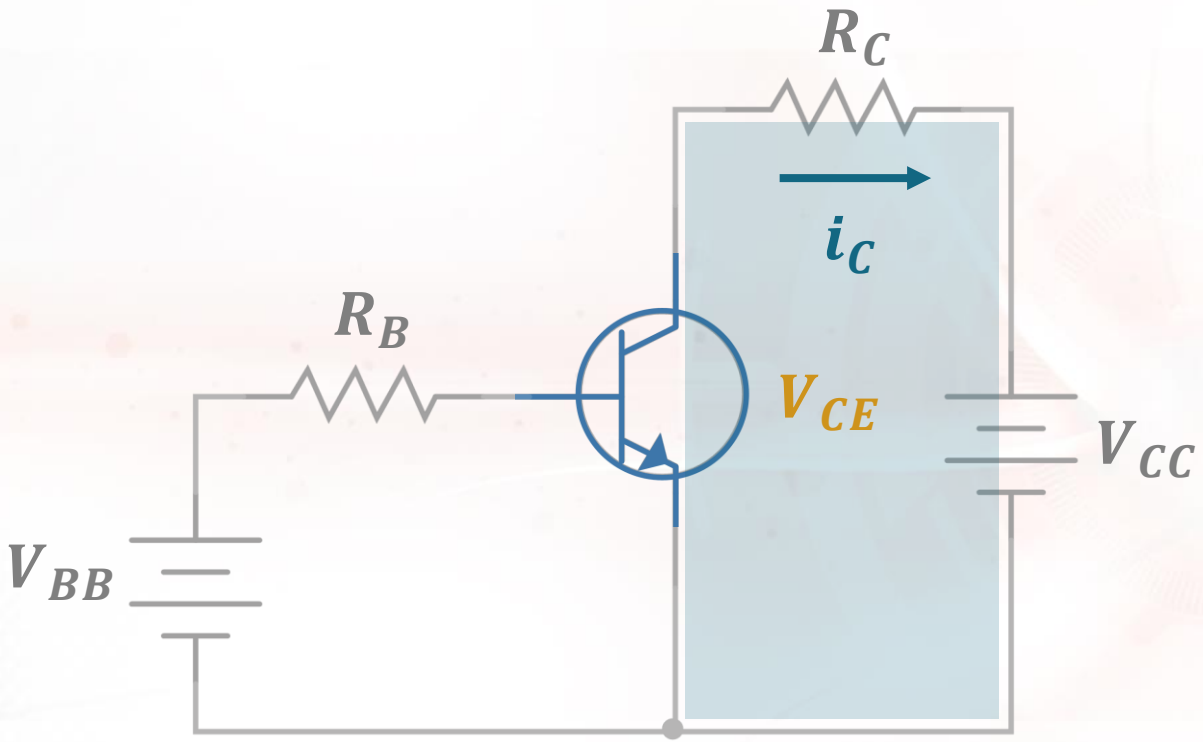


$$i_B = \frac{V_{BB} - V_{BE}}{R_B}$$


R_C
i_C
R_B
V_{CE}
V_{CC}
V_{BB}


i_C
Breakdown Region
V_{CE}

Collector-Emitter Loop,



$$V_{CE} = V_{CC} - i_c R_c$$

Alpha,

$$\alpha_{dc} = \frac{i_C}{i_E}$$

Beta,

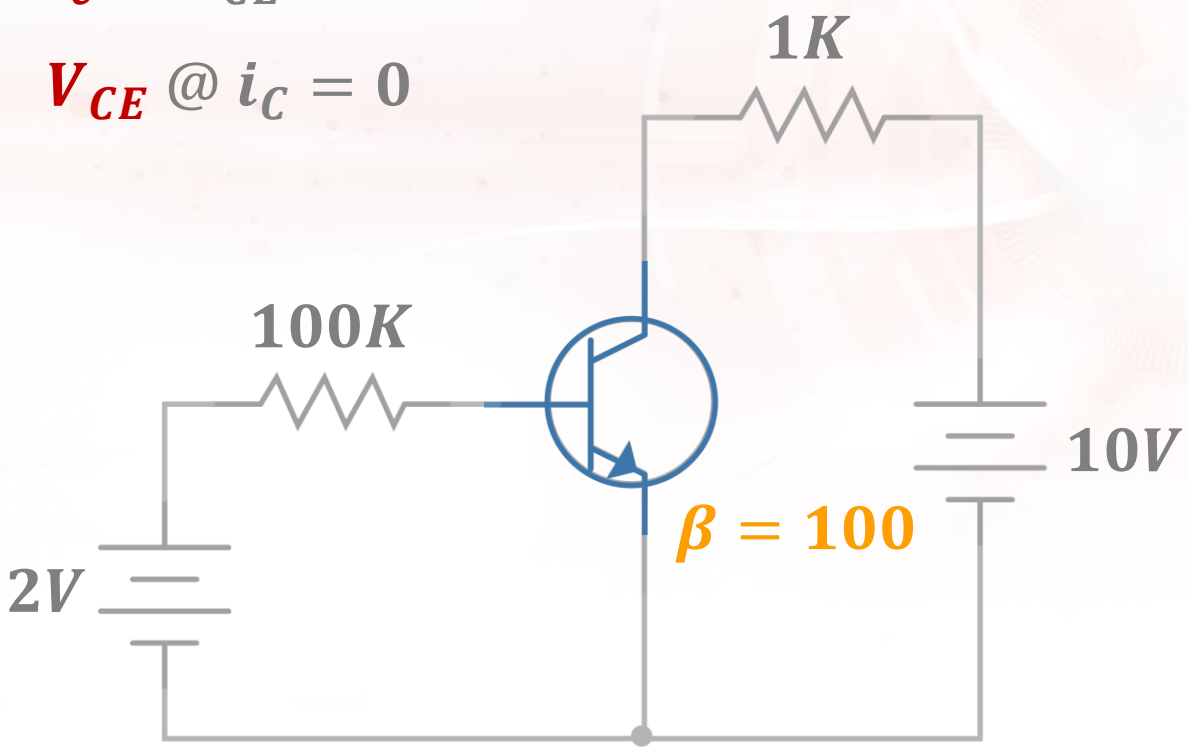
$$\beta_{dc} = \frac{i_C}{i_B}$$

Determine the parameters of the given transistor network.

$\boldsymbol{i_B}, \boldsymbol{i_C}$, and $\boldsymbol{V_{CE}}$

$\boldsymbol{i_c}$ @ $V_{CE} = 0$

$\boldsymbol{V_{CE}}$ @ $i_C = 0$

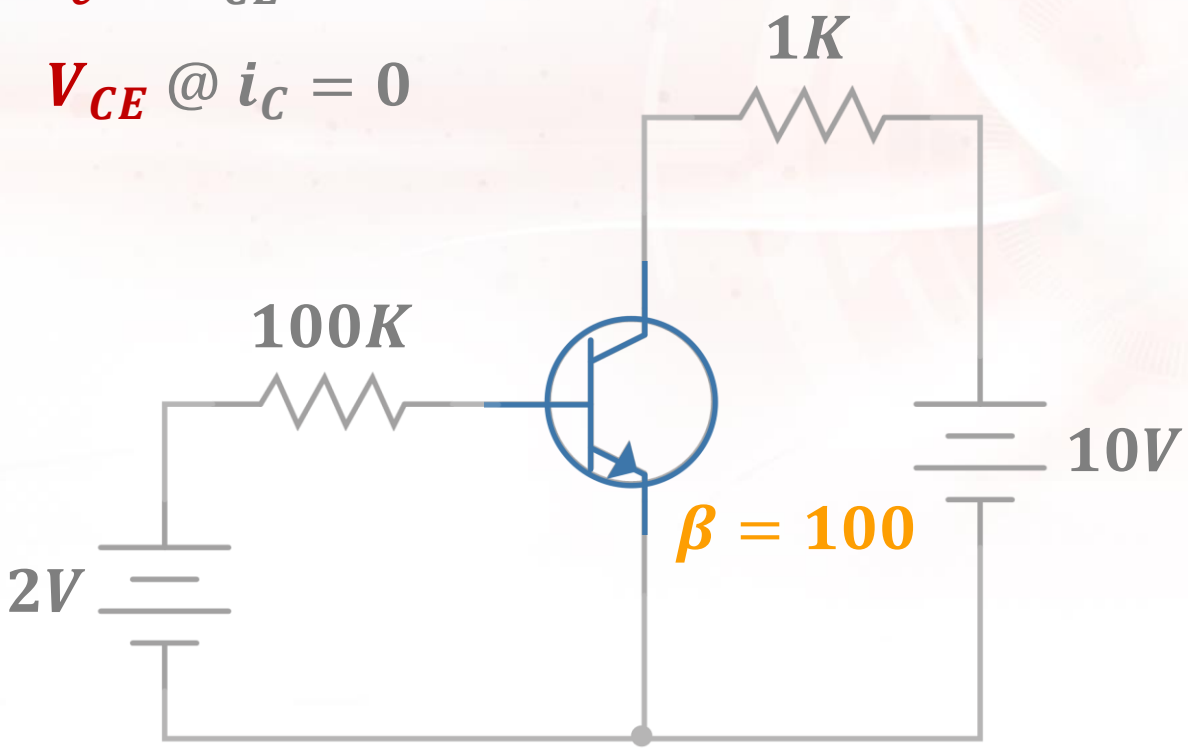


Determine the parameters of the given transistor network.

i_B, i_C, and V_{CE}

i_c @ $V_{CE} = 0$

V_{CE} @ $i_C = 0$



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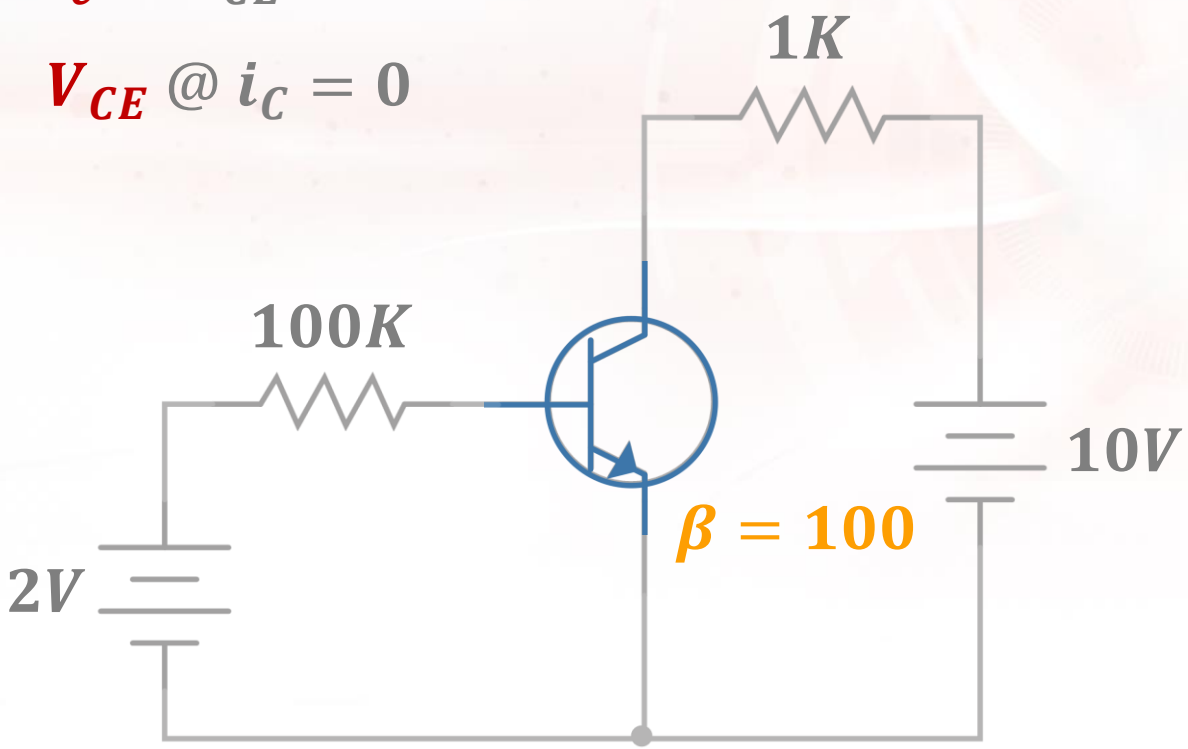

Determine the parameters of the given transistor network.

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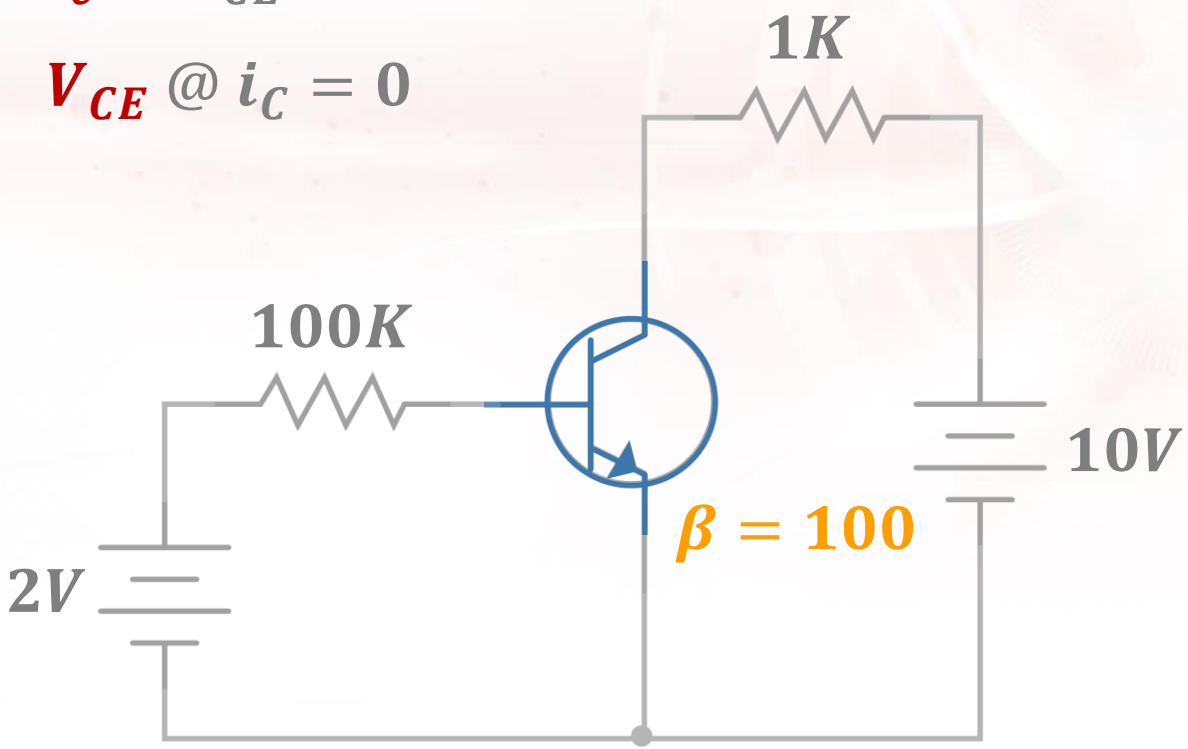
V_{CE} @ $i_C = 0$



Determine the parameters of the given transistor network.

i_B, i_C, and V_{CE}

i_c @ $V_{CE} = 0$

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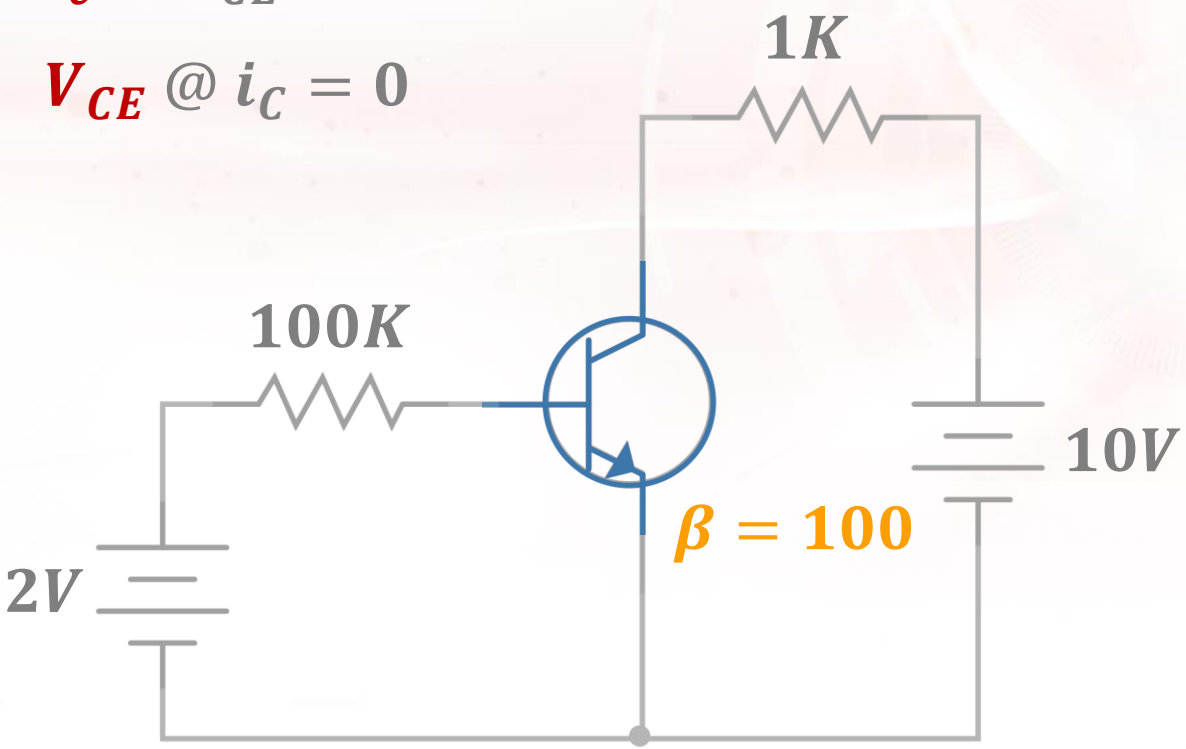
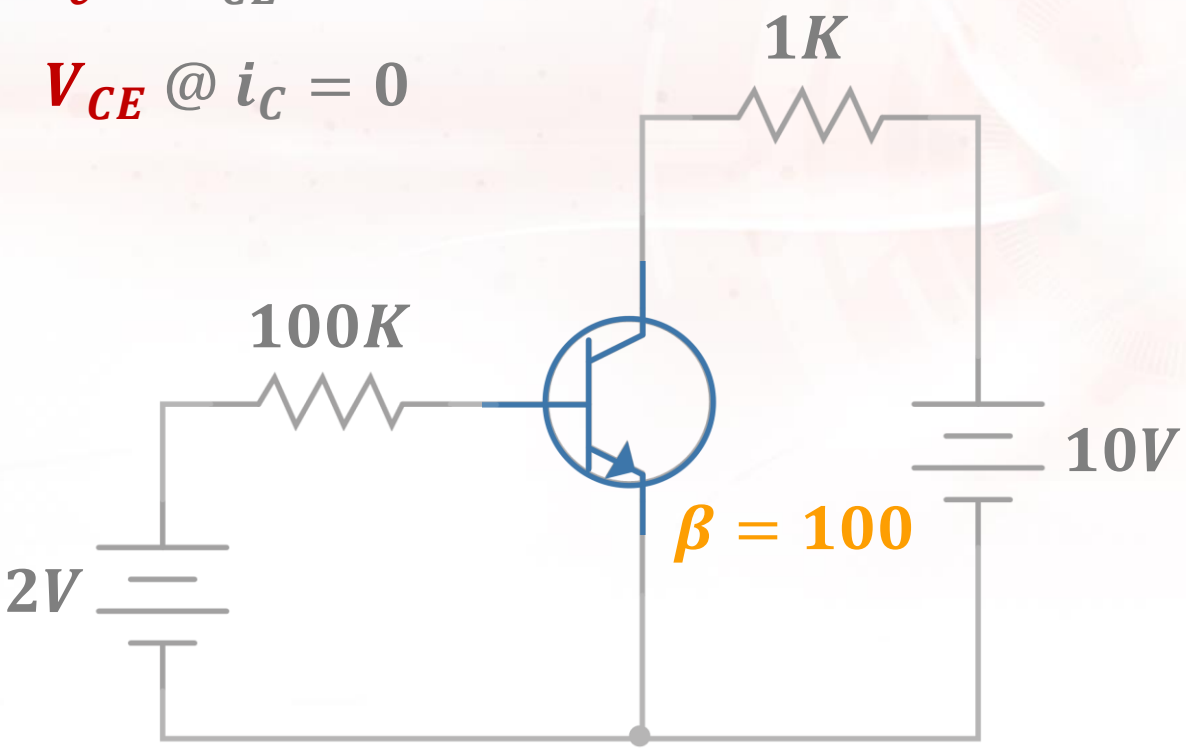


Determine the parameters of the given transistor network.

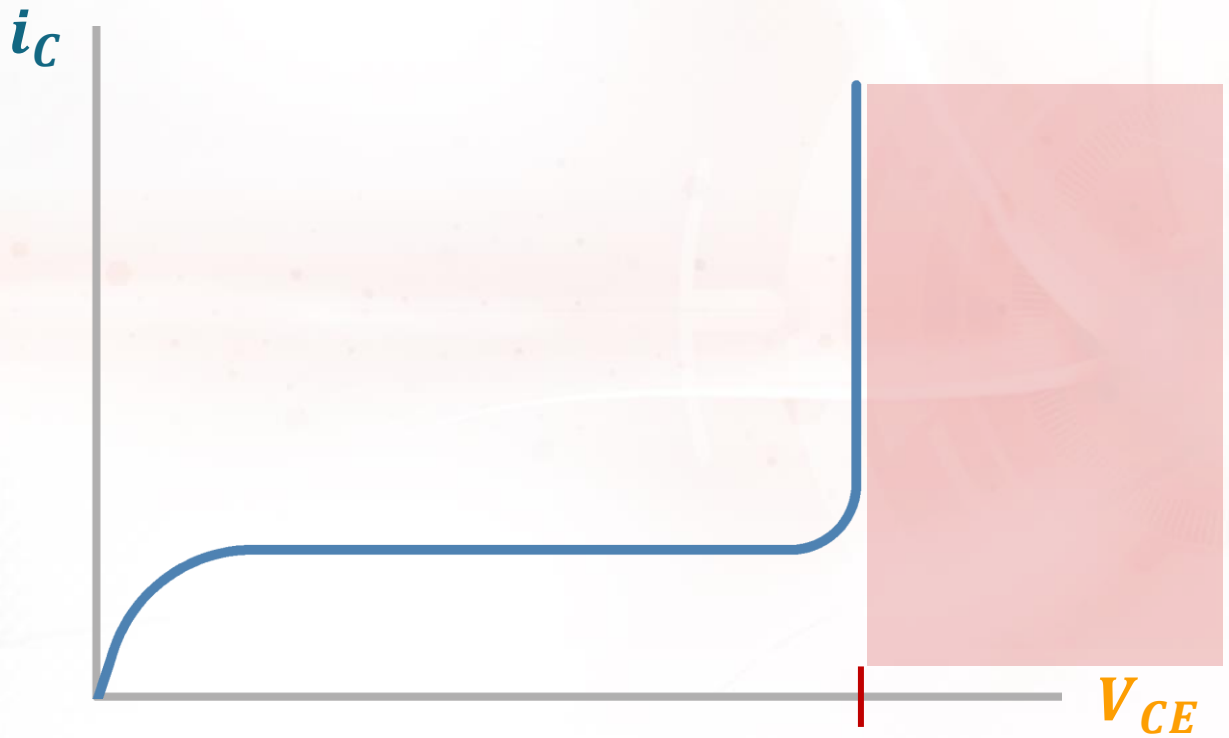
i_B, i_C, and V_{CE}

i_c @ $V_{CE} = 0$

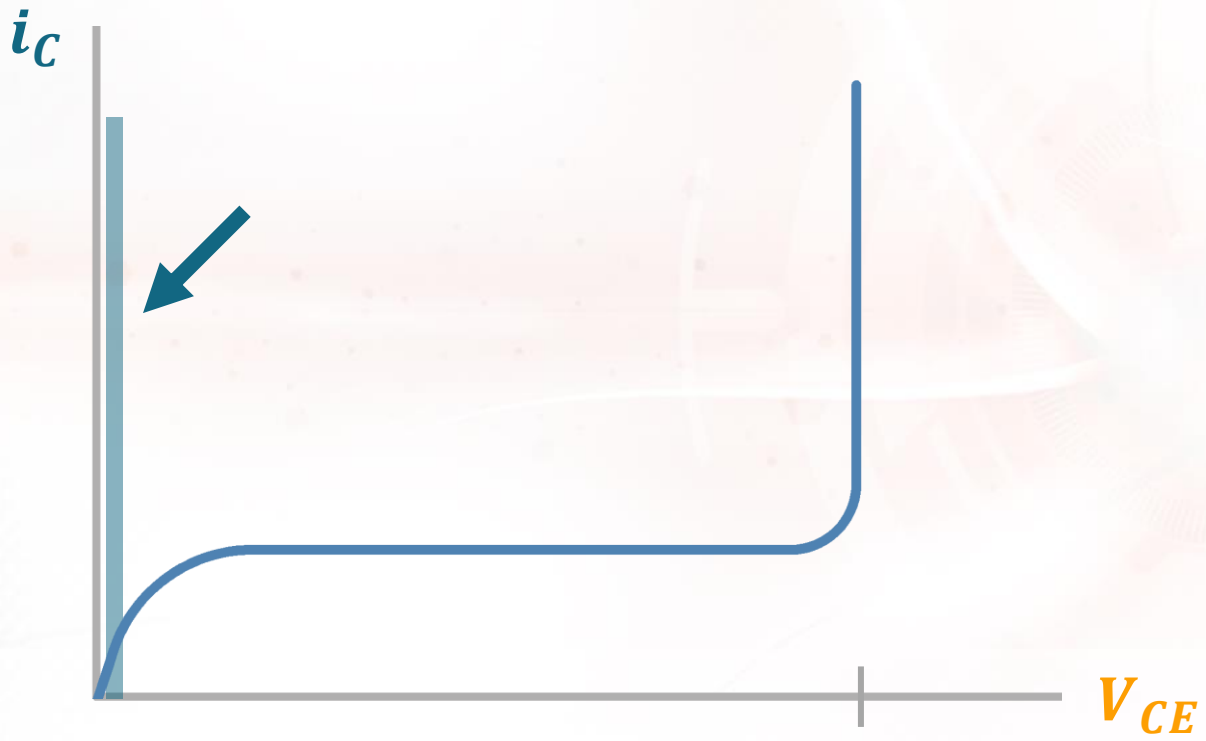
V_{CE} @ $i_C = 0$



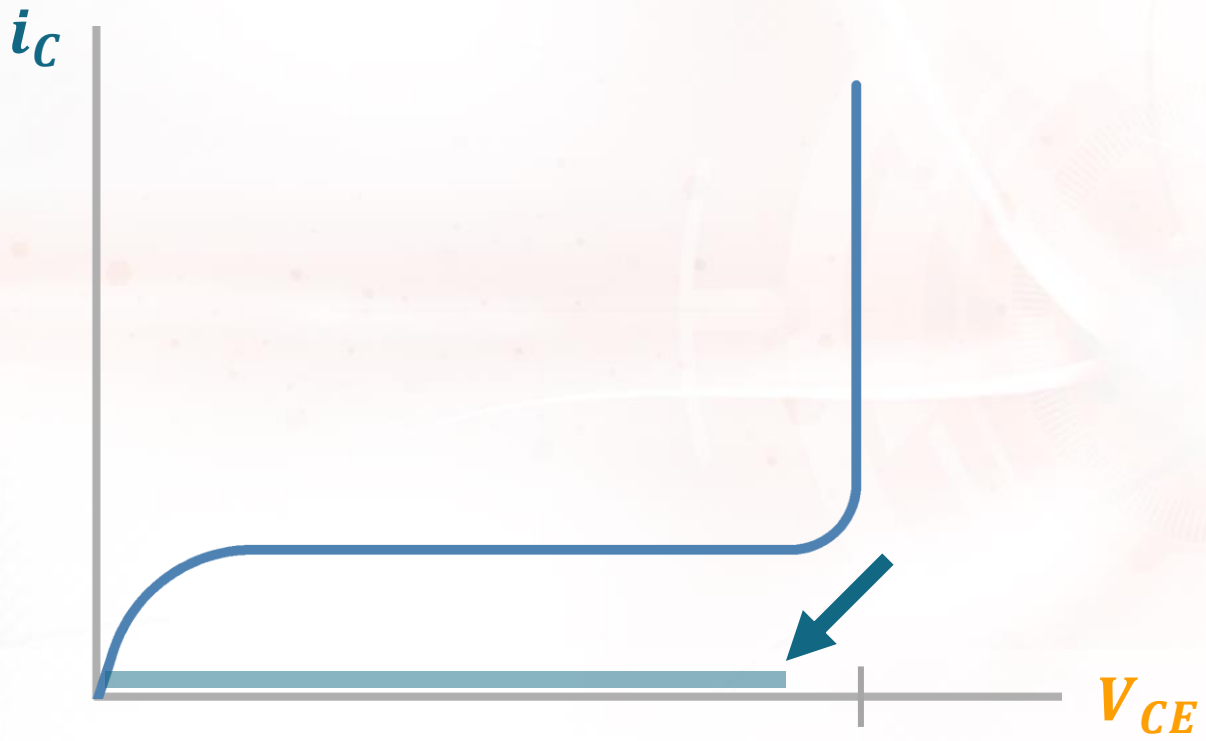
REGIONS OF OPERATION



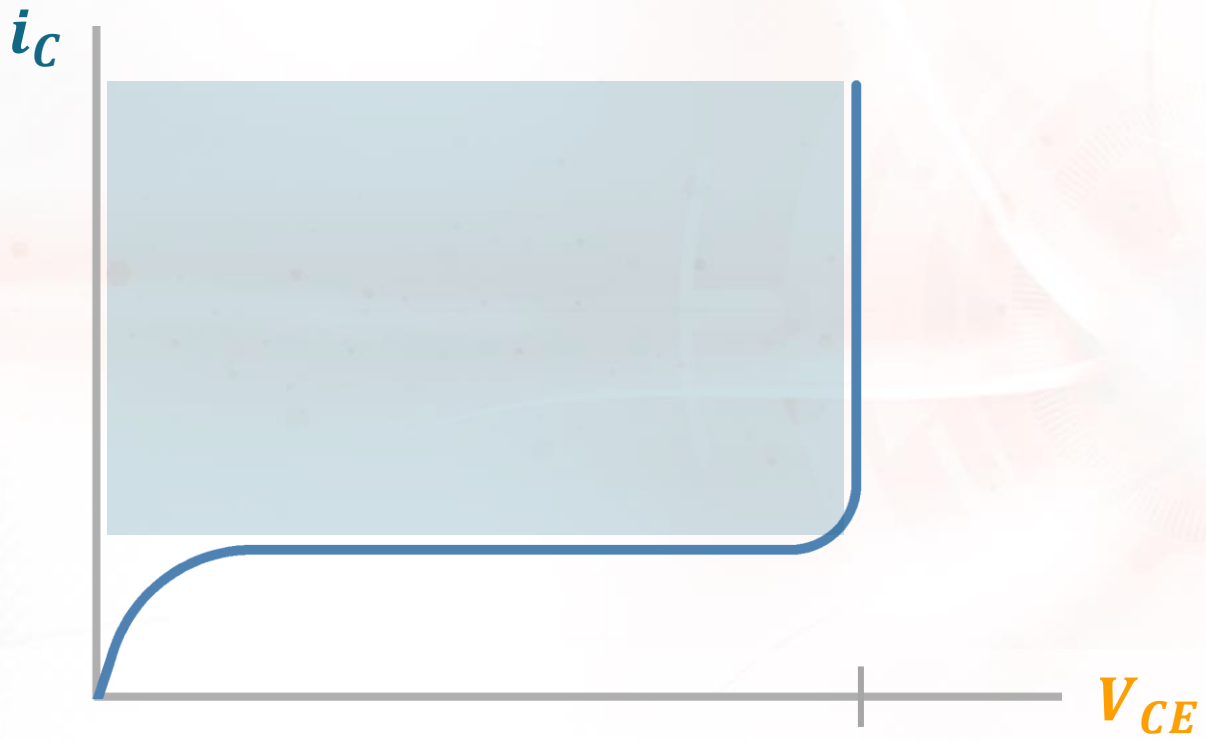
The transistor should never operate in this region because it will be **destroyed**



The early rising part of the curve, where V_{CE} is between **0V** and few tenths of a volt



A **small collector current** when the base current is zero

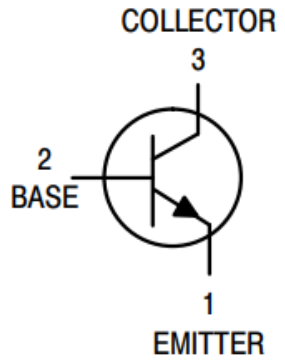


Collector current is **constant** in this region

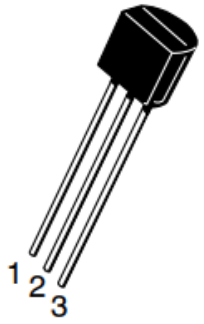
READING DATASHEET

MAXIMUM RATINGS

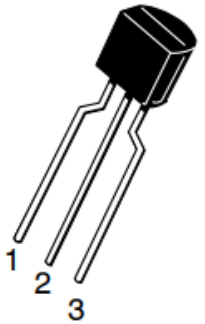
Rating	Symbol	Value	Unit
Collector – Emitter Voltage	V_{CEO}	40	Vdc
Collector – Base Voltage	V_{CBO}	60	Vdc
Emitter – Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C



TO–92
CASE 29
STYLE 1



STRAIGHT LEAD
BULK PACK



BENT LEAD
TAPE & REEL
AMMO PACK

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (Note 2)		h_{FE}			–
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	2N3903		20	–	
	2N3904		40	–	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N3903		35	–	
	2N3904		70	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	2N3903		50	150	
	2N3904		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	2N3903		30	–	
	2N3904		60	–	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	2N3903		15	–	
	2N3904		30	–	
Collector – Emitter Saturation Voltage (Note 2)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			–	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc			–	0.3	
Base – Emitter Saturation Voltage (Note 2)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			–	0.95	

LABORATORY