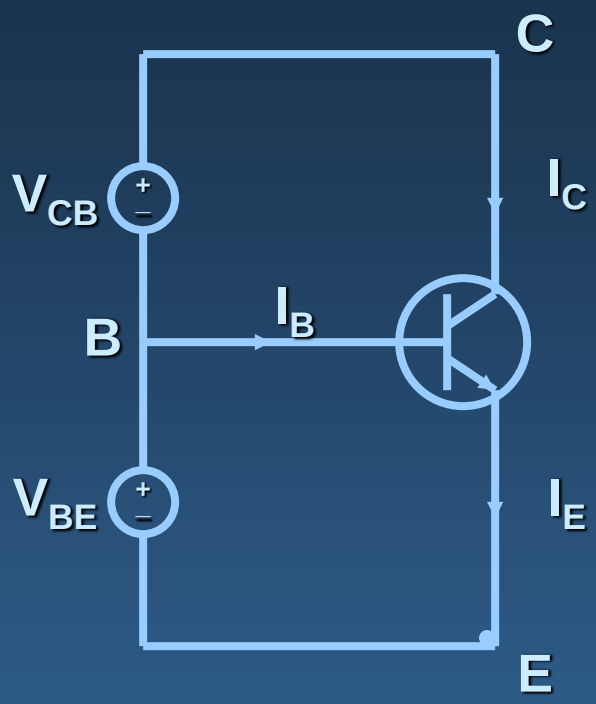
BJT Example

Using Common-Base NPN Circuit Configuration



Given: $I_B = 50\ \mu A$, $I_C = 1$ mA

Find: I_E , β , and α

Solution:

$I_E = I_B + I_C = 0.05$ mA + 1 mA = 1.05 mA

$\beta = I_C / I_B = 1$ mA / 0.05 mA = 20

$\alpha = I_C / I_E = 1$ mA / 1.05 mA = 0.95238

α could also be calculated using the value of β with the formula from the previous slide.

$$\alpha = \frac{\beta}{\beta + 1} = \frac{20}{21} = 0.95238$$

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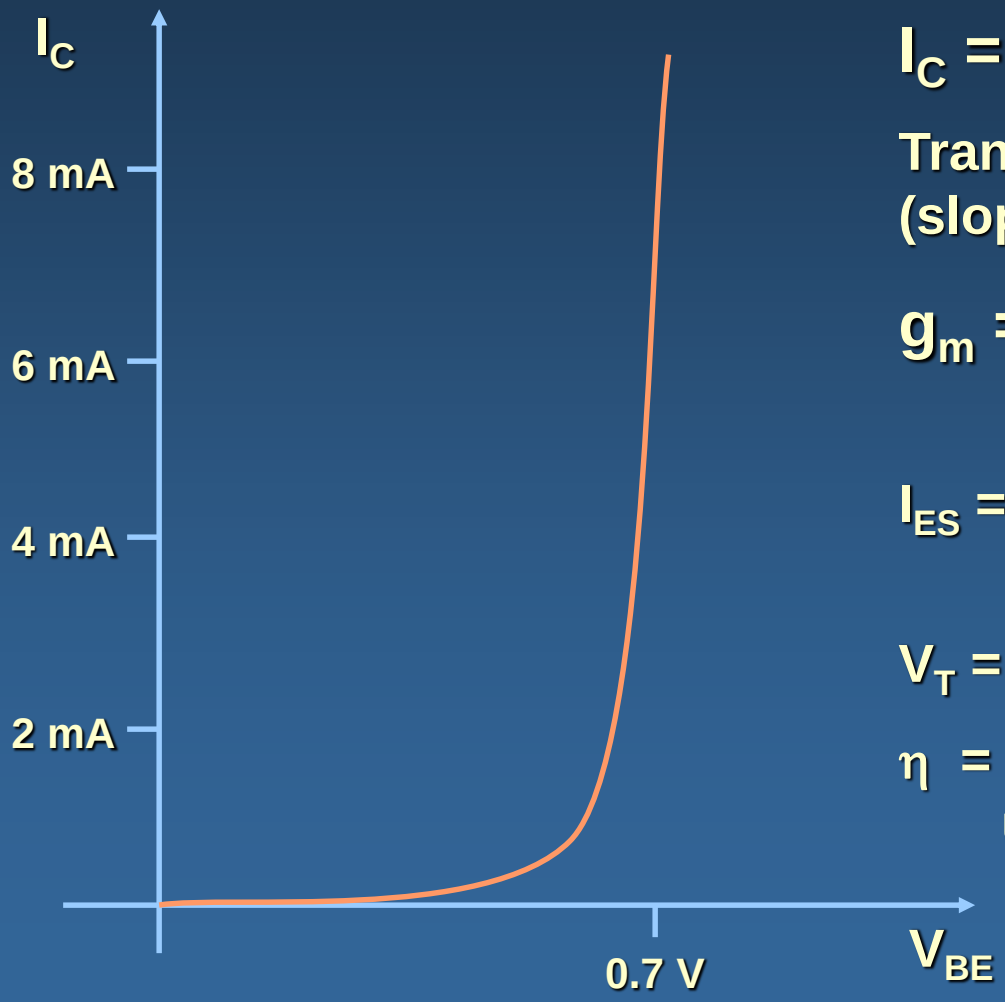
BJT Transconductance Curve

Typical NPN Transistor [1]



Collector Current:

$$I_C = \alpha I_{ES} e^{V_{BE}/\eta V_T}$$

Transconductance: (slope of the curve)

$$g_m = \delta I_C / \delta V_{BE}$$

I_{ES} = The reverse saturation current of the B-E Junction.

$V_T = kT/q = 26$ mV (@ T=300K)

η = the emission coefficient and is usually ~1

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Modes of Operation

Active:

- Most important mode of operation
- Central to amplifier operation
- The region where current curves are practically flat

Saturation:

- Barrier potential of the junctions cancel each other out causing a virtual short

Cutoff:

- Current reduced to zero
- Ideal transistor behaves like an open switch

* Note: There is also a mode of operation called inverse active, but it is rarely used.

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Three Types of BJT Biasing

Biasing the transistor refers to applying voltage to get the transistor to achieve certain operating conditions.

Common-Base Biasing (CB) :

input = V_{EB} & I_E

output = V_{CB} & I_C

Common-Emitter Biasing (CE):

input = V_{BE} & I_B

output = V_{CE} & I_C

Common-Collector Biasing (CC):

input = V_{BC} & I_B

output = V_{EC} & I_E

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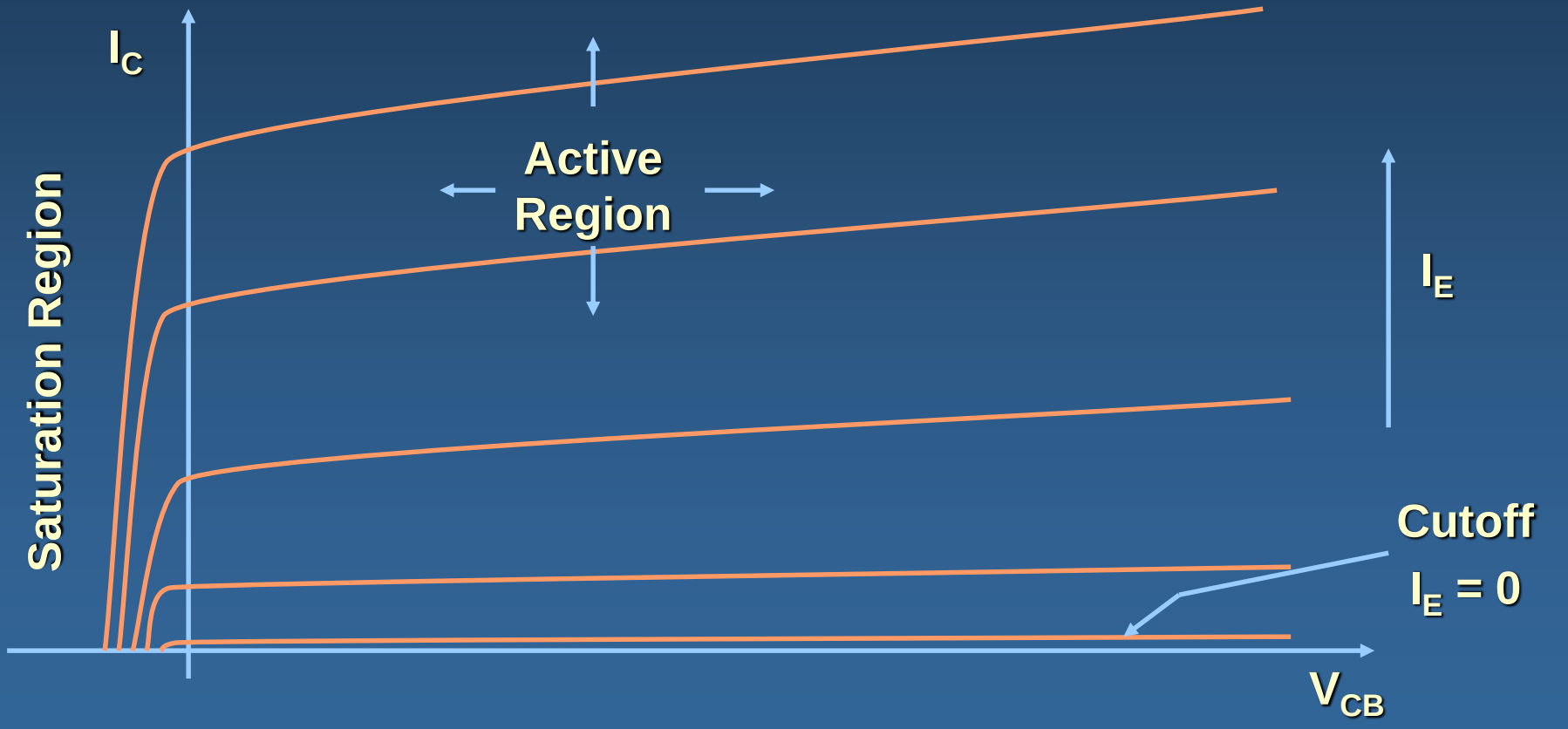
Common-Base

Although the Common-Base configuration is not the most common biasing type, it is often helpful in the understanding of how the BJT works.

Emitter-Current Curves



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