



# FIXED-BIAS CIRCUIT

## BJT DC BIASING

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# TOPIC OUTLINE

## Fixed-Bias Circuit

- Base-Emitter Loop
- Collector-Emitter Loop
- Load Line Analysis



# FIXED-BIAS CIRCUIT



# CURRENT GAIN

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The current gain parameters alpha ( $\alpha$ ) and beta ( $\beta$ ) describe the relationship between currents in the transistor's three terminals (emitter, base, and collector).

Alpha ( $\alpha$ ) is the ratio of the collector current to the emitter current.

Formula

$$\alpha = \frac{i_C}{i_E}$$

$\alpha$  is always less than 1 (typically 0.95 to 0.995)

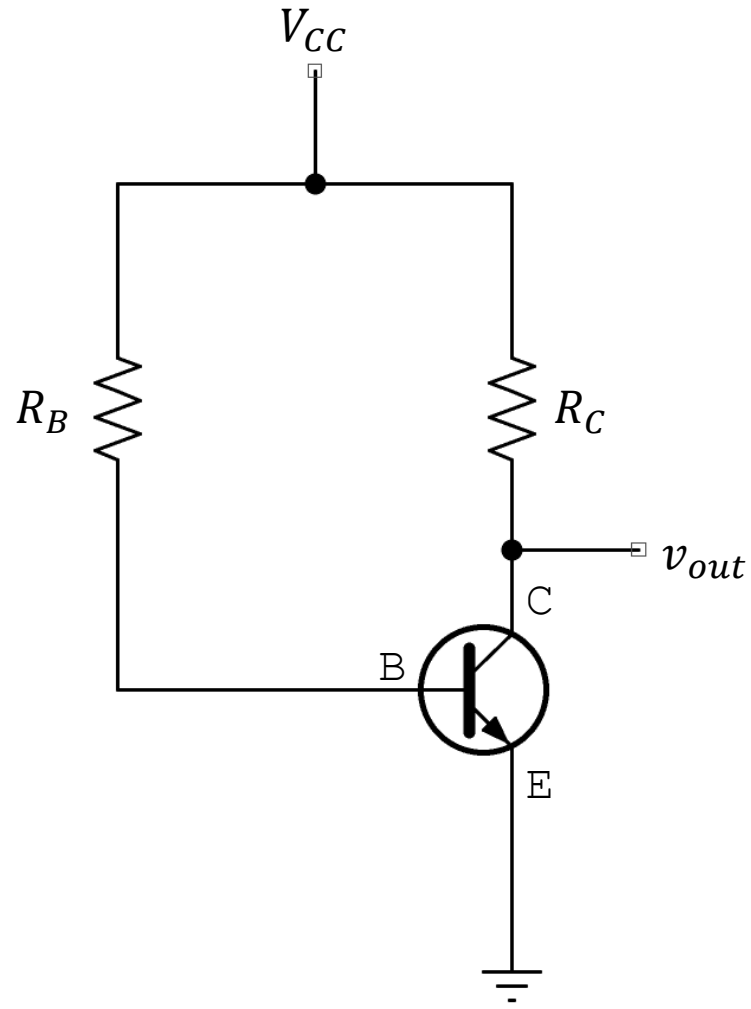
Beta ( $\beta$ ) is the ratio of the collector current to the base current.

Formula

$$\beta = \frac{i_C}{i_B}$$



# FIXED-BIAS CIRCUIT



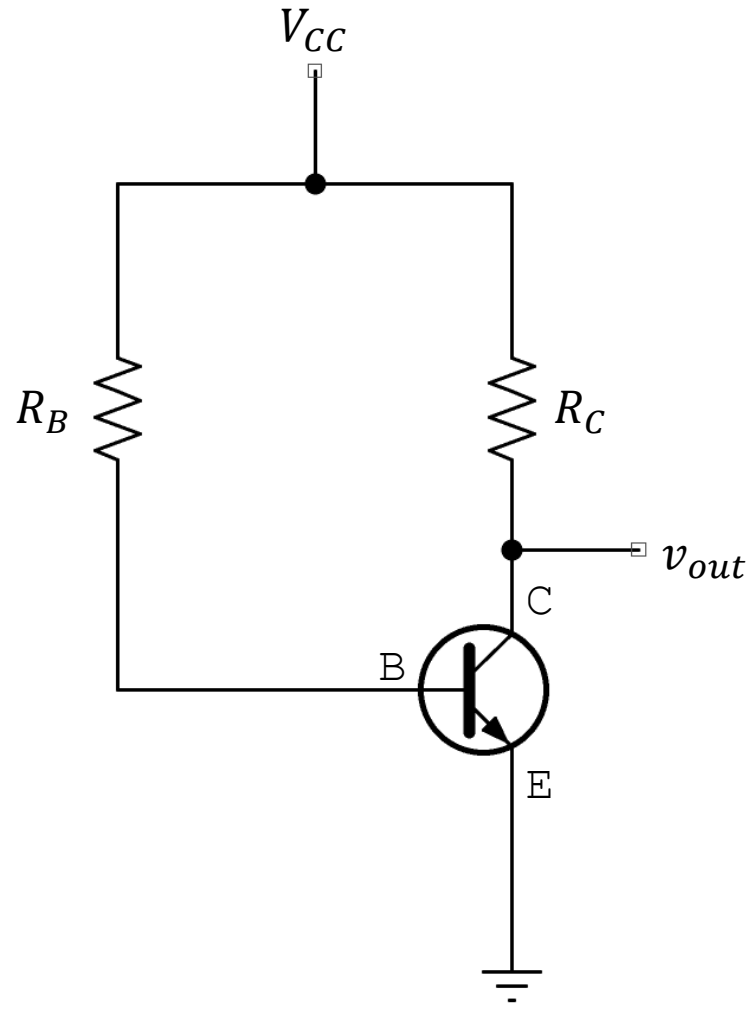
Fixed-bias configuration is the simplest method – the biasing voltage applied to the base of the BJT is fixed by a single resistor ( $R_B$ ) connected directly to the power supply ( $v_{CC}$ ).



# BASE-EMITTER LOOP

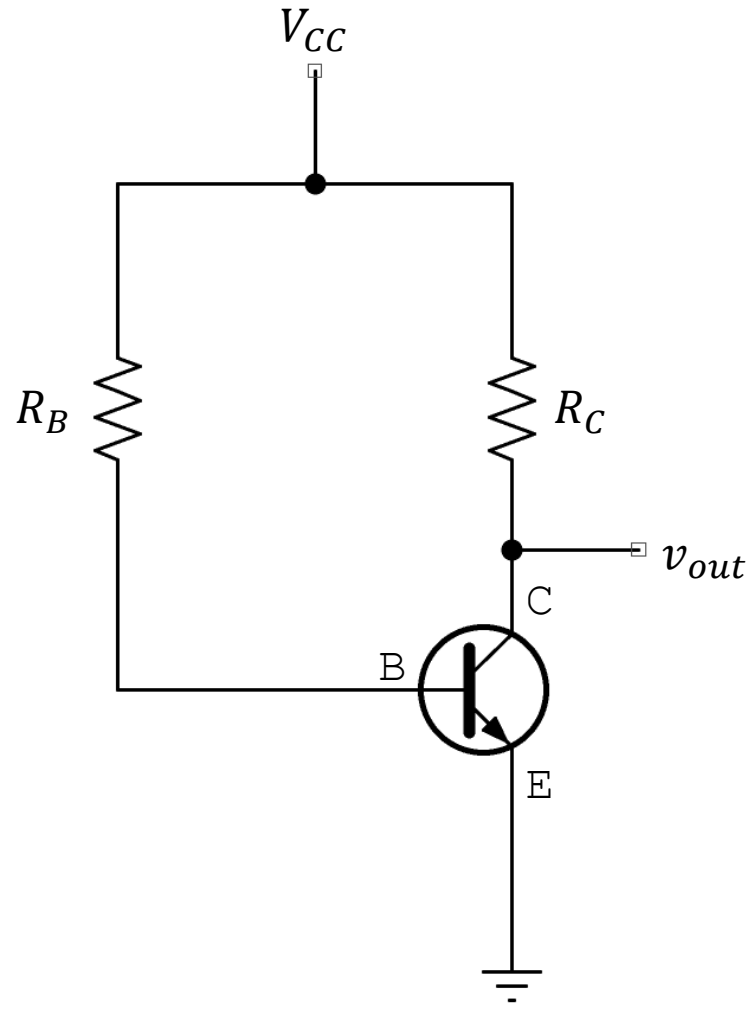
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KVL @B-E

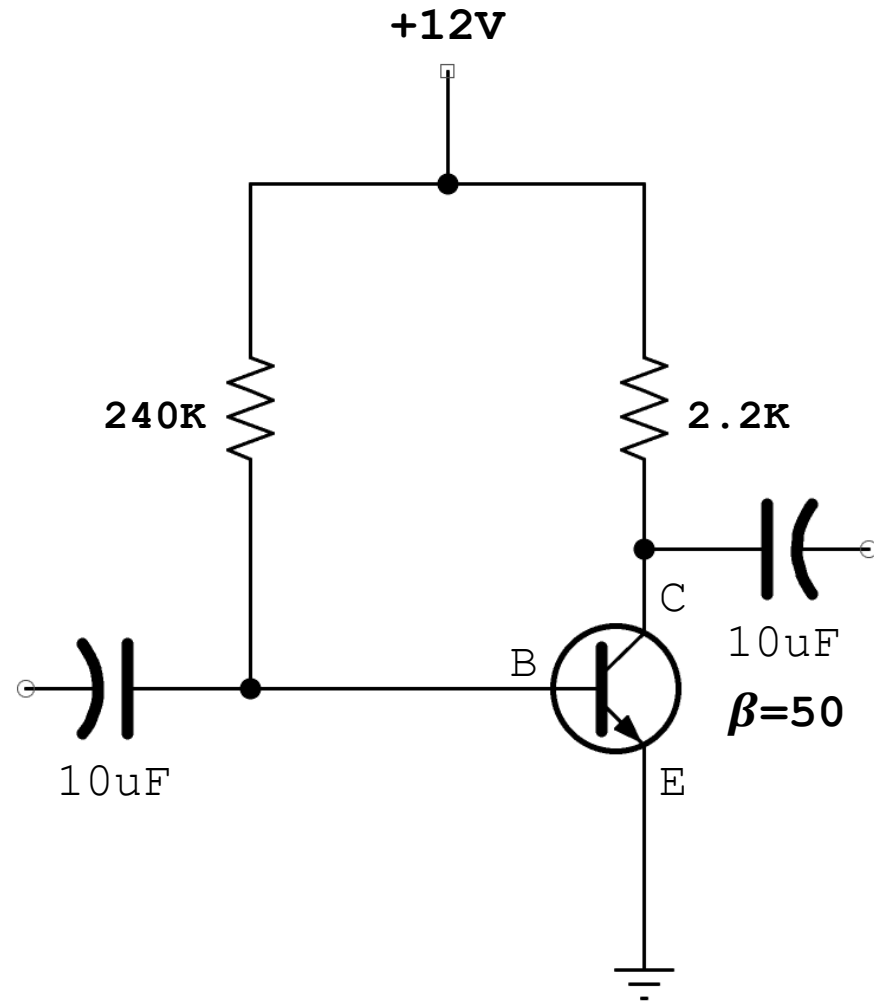


# COLLECTOR-EMITTER LOOP

KVL @C-E



## EXERCISE



Determine the following parameters for the given fixed-bias circuit:

- Base current ( $i_{BQ}$ )
- Collector current ( $i_{CQ}$ )
- Collector-Emitter voltage ( $v_{CEQ}$ )
- Base voltage ( $v_B$ )
- Base-Collector voltage ( $v_{BC}$ )

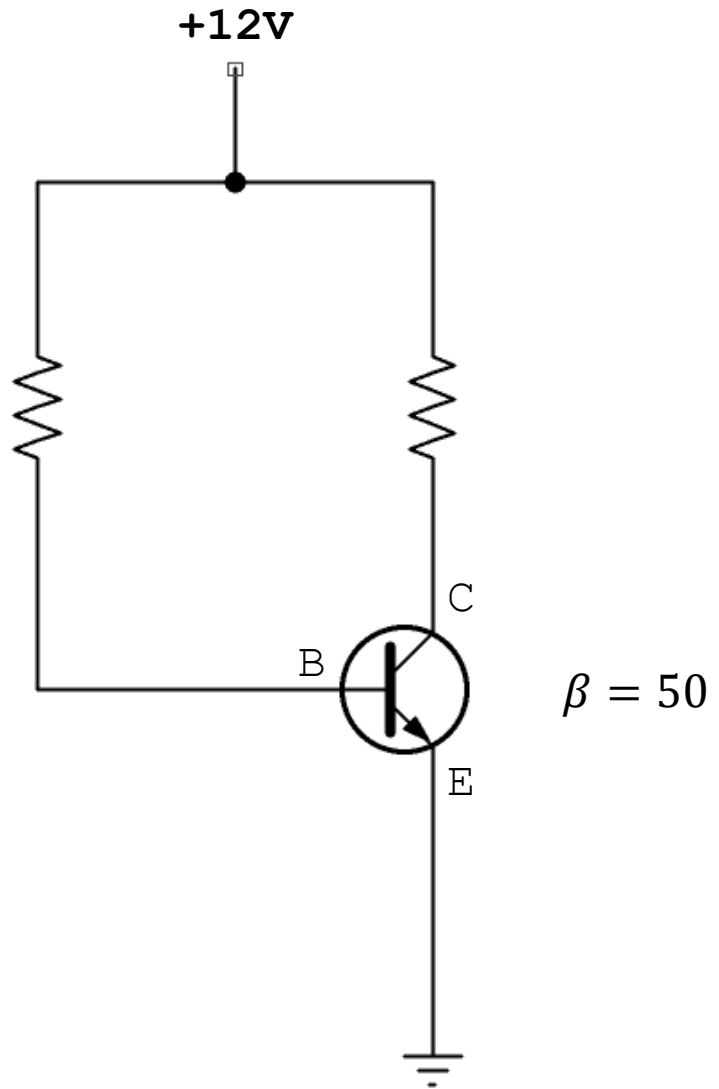




## EXERCISE

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Solution



# LOAD LINE ANALYSIS

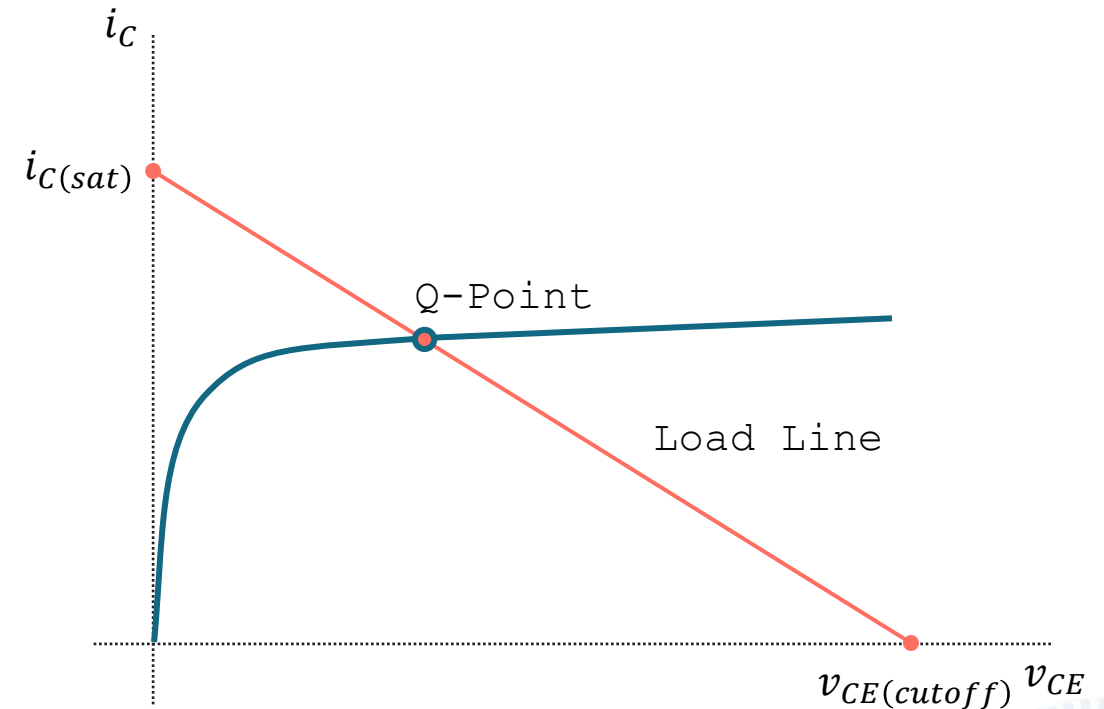


# SATURATION POINT

The saturation point is the operating state where BJT conducts the maximum collector current ( $i_{C(sat)}$ ) with zero collector-emitter voltage ( $v_{CE} = 0$ ).

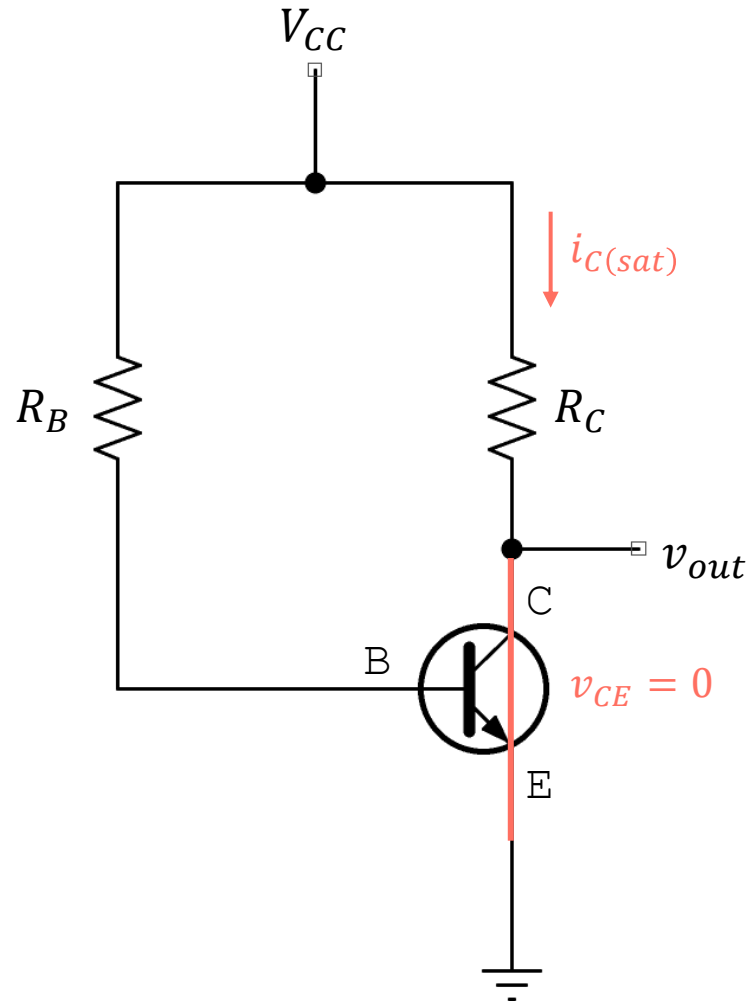
In this region the transistor acts like a closed switch (zero resistance between collector-emitter).

Collector Characteristic Curve

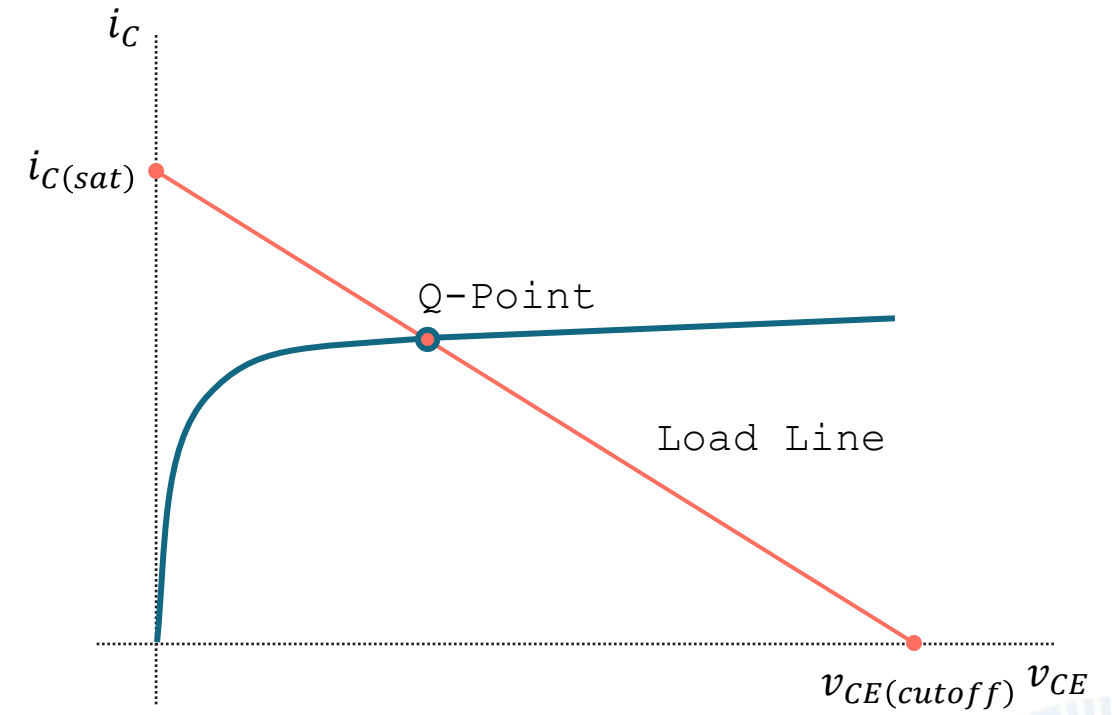


# SATURATION POINT

Mentally Short



Collector Characteristic Curve

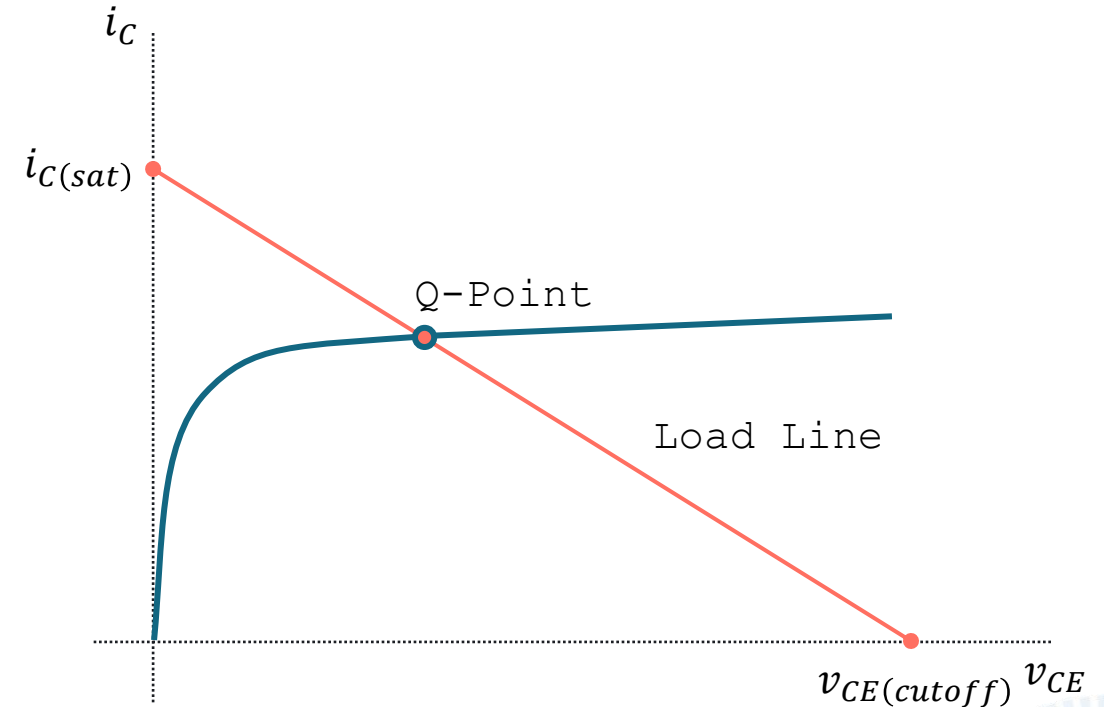


# CUTOFF POINT

The cutoff point is the operating state where BJT conducts zero collector current ( $i_C = 0$ ) with  $v_{CE}$  at its maximum ( $v_{CE} = V_{CC}$ ).

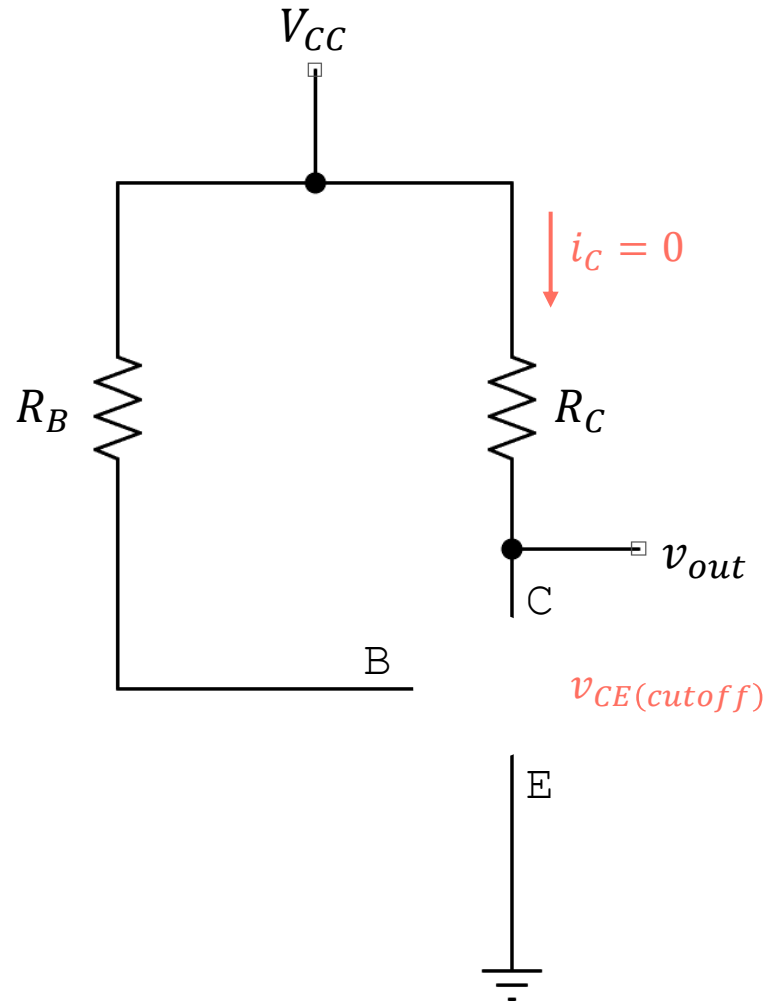
In this region the transistor acts like an open switch (infinite resistance between collector-emitter).

Collector Characteristic Curve

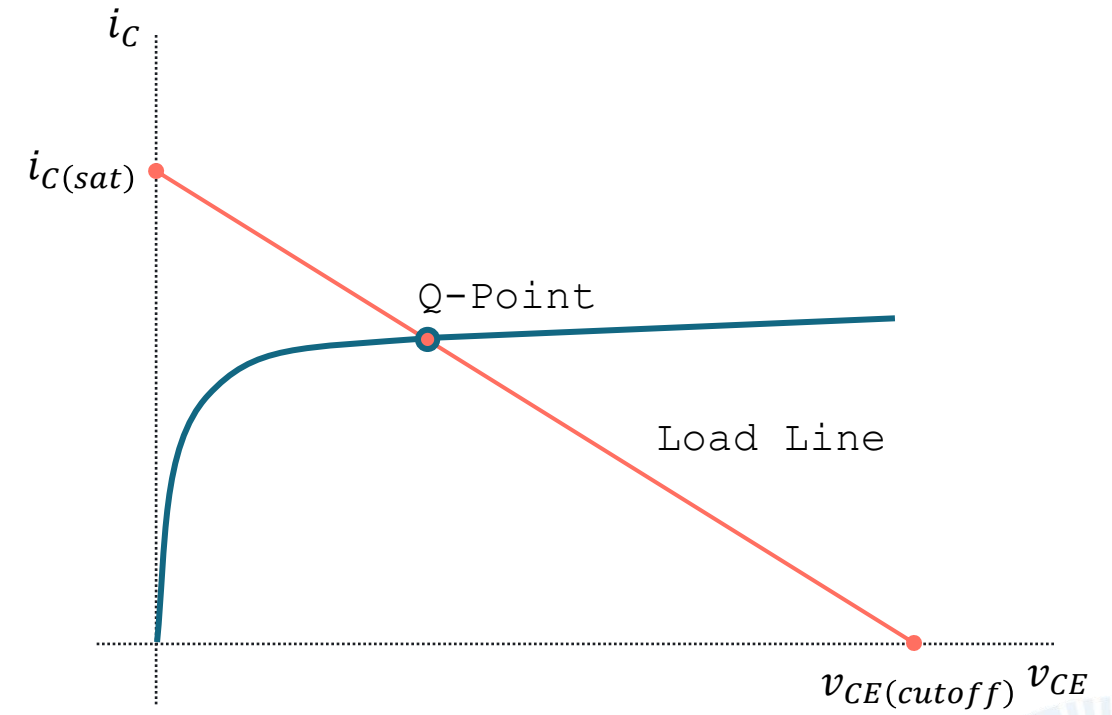


# CUTOFF POINT

Mentally Open



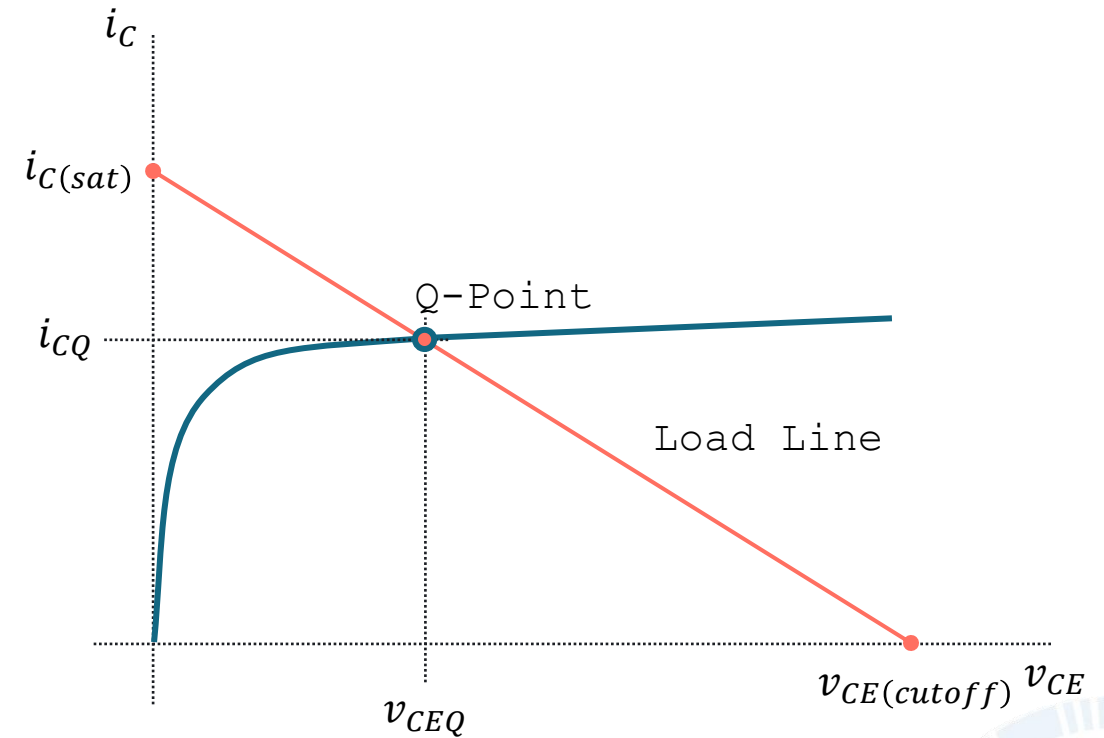
Collector Characteristic Curve



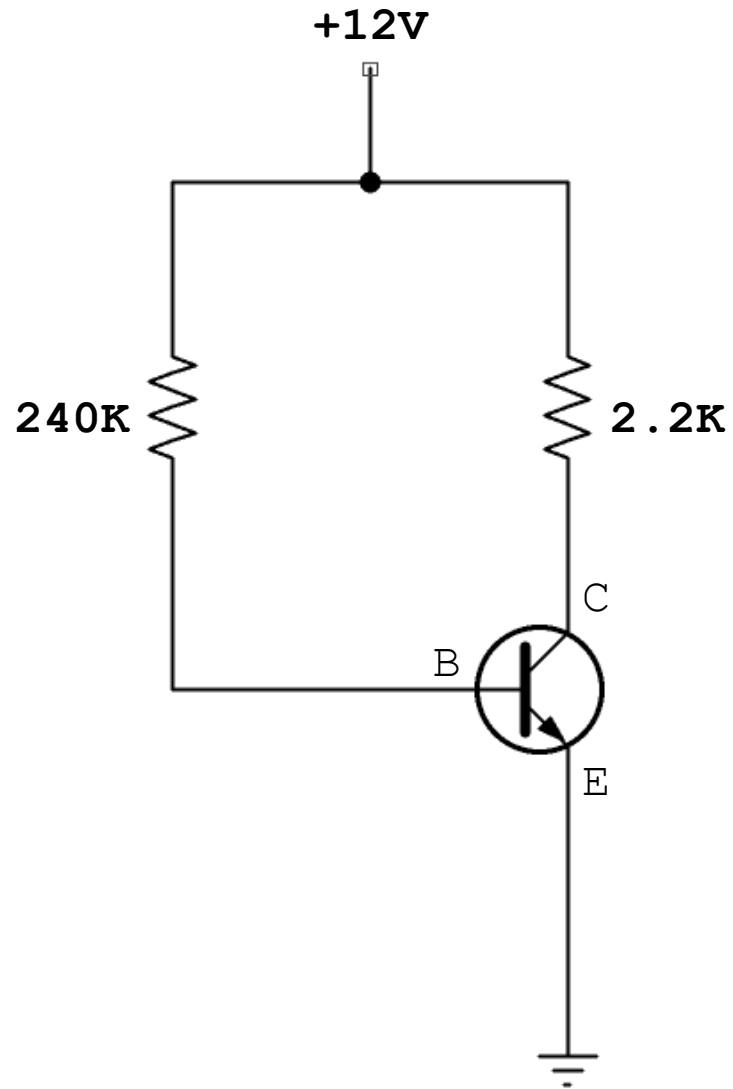
# QUIESCENT POINT

The Q-point is the stable DC operating condition characterized by specific value of collector current ( $i_C$ ) and collector-emitter voltage ( $v_{CE}$ ).

Collector Characteristic Curve



## EXERCISE



Plot the DC load line for the fixed-bias circuit and clearly indicate the following points on the graph.

- Saturation current ( $i_{C(sat)}$ )
- Cutoff voltage ( $v_{CE(cutoff)}$ )
- Operating Point (Q-Point)

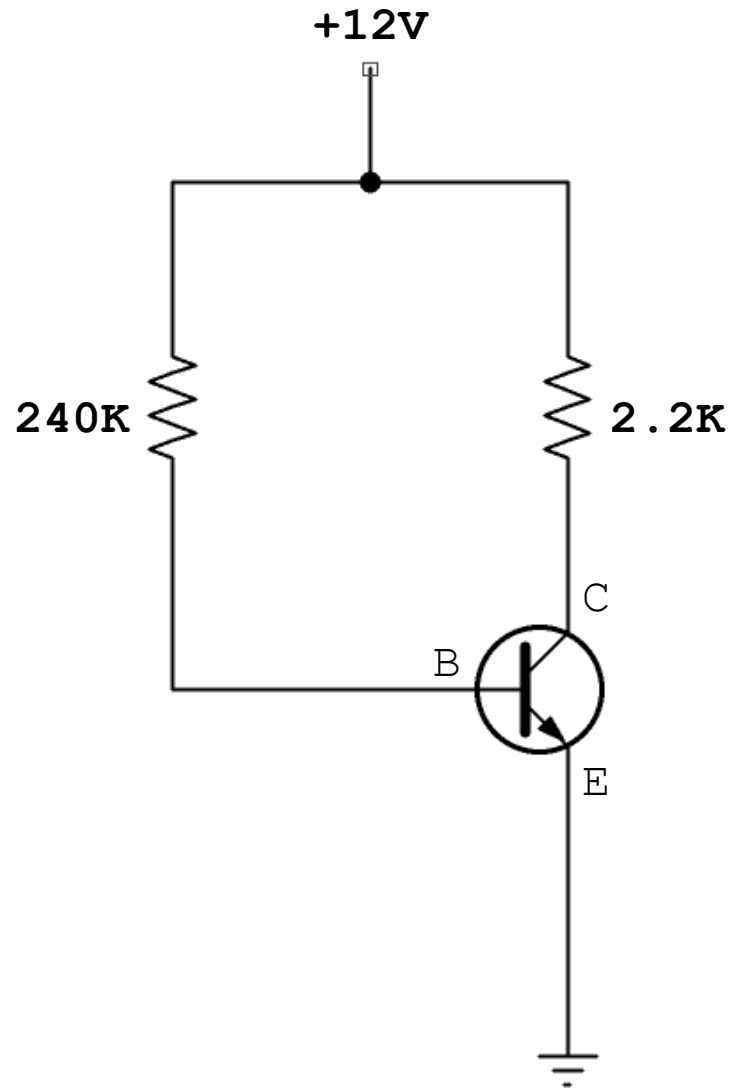




## EXERCISE

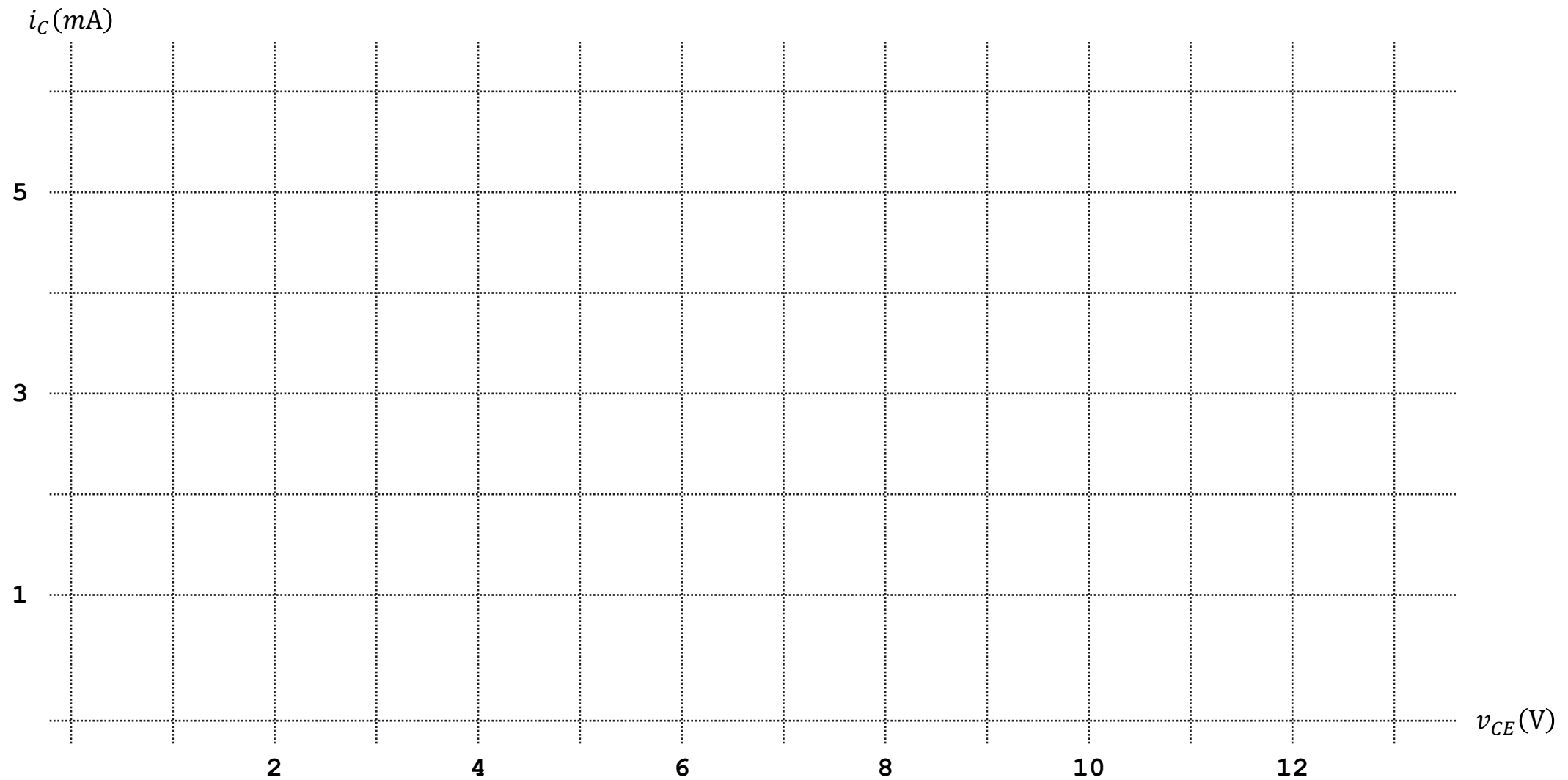
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Solution

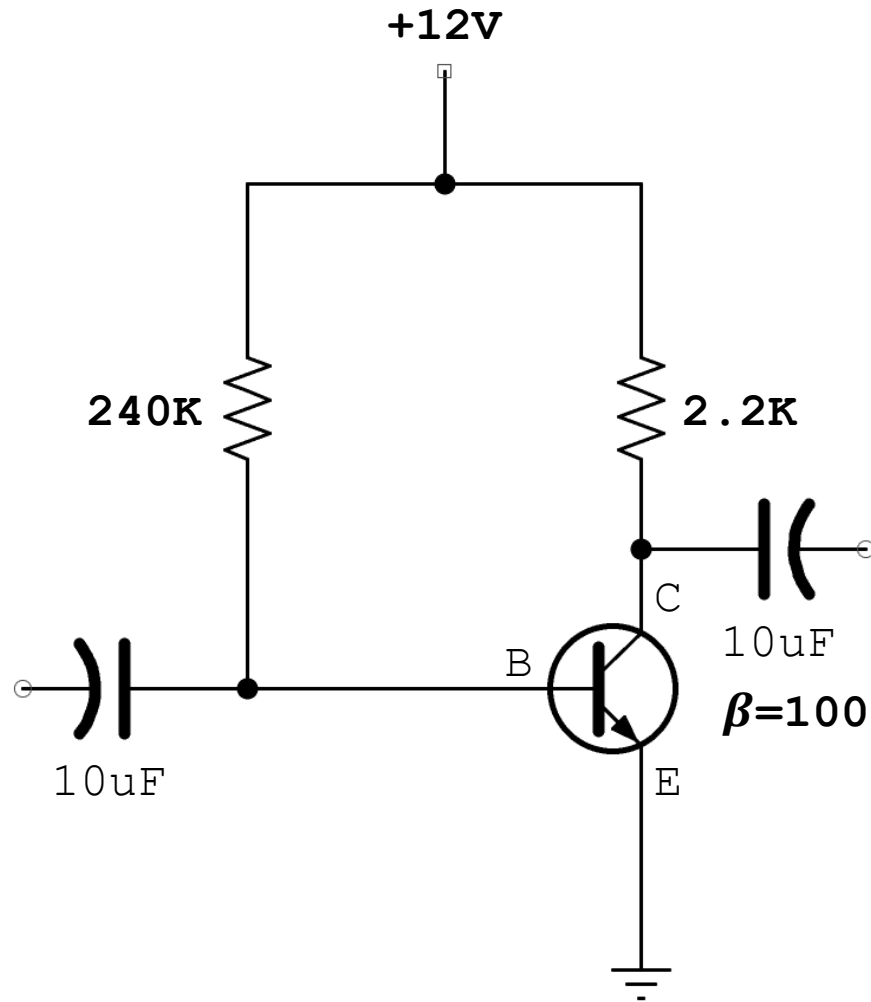


# EXERCISE

## Load Line Analysis



## EXERCISE



Determine the following parameters for the given fixed-bias circuit:

- Base current ( $i_{BQ}$ )
- Collector current ( $i_{CQ}$ )
- Collector-Emitter voltage ( $v_{CEQ}$ )

and clearly indicate the following points on the load line analysis graph.

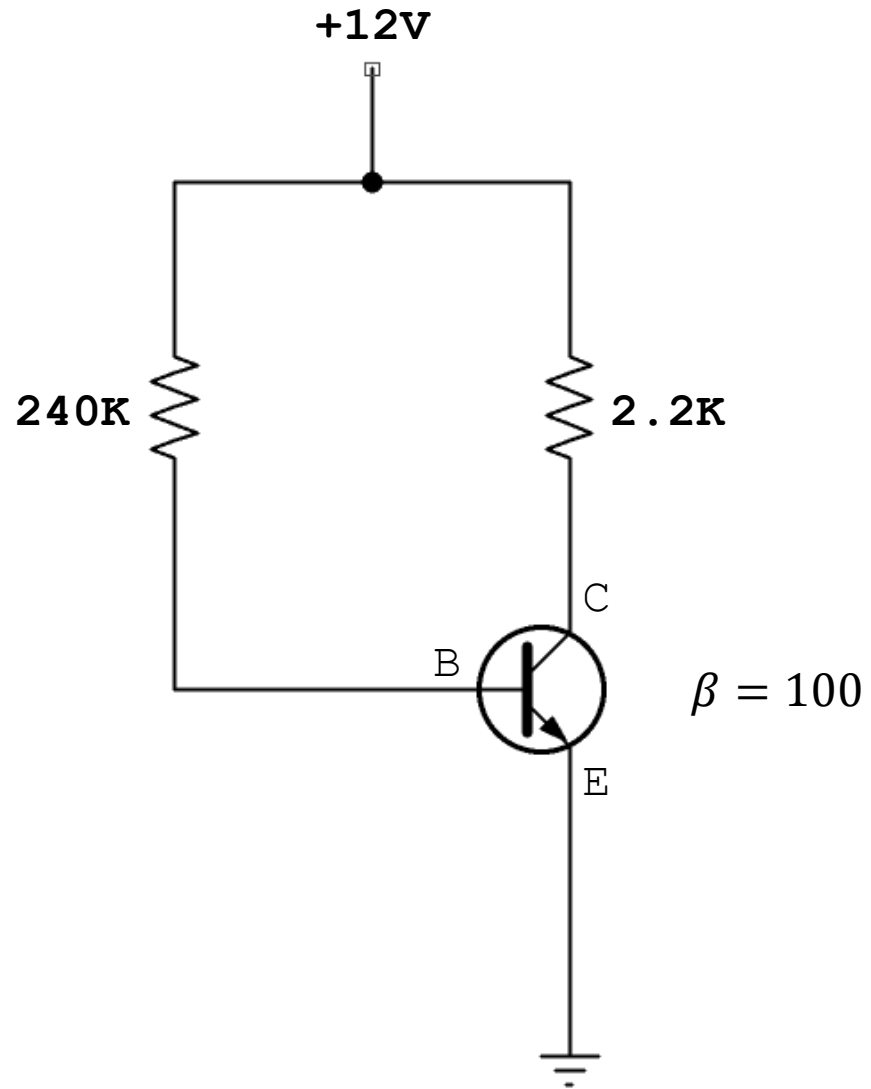
- Saturation current ( $i_{C(sat)}$ )
- Cutoff voltage ( $v_{CE(cutoff)}$ )
- Operating Point (Q-Point)



## EXERCISE

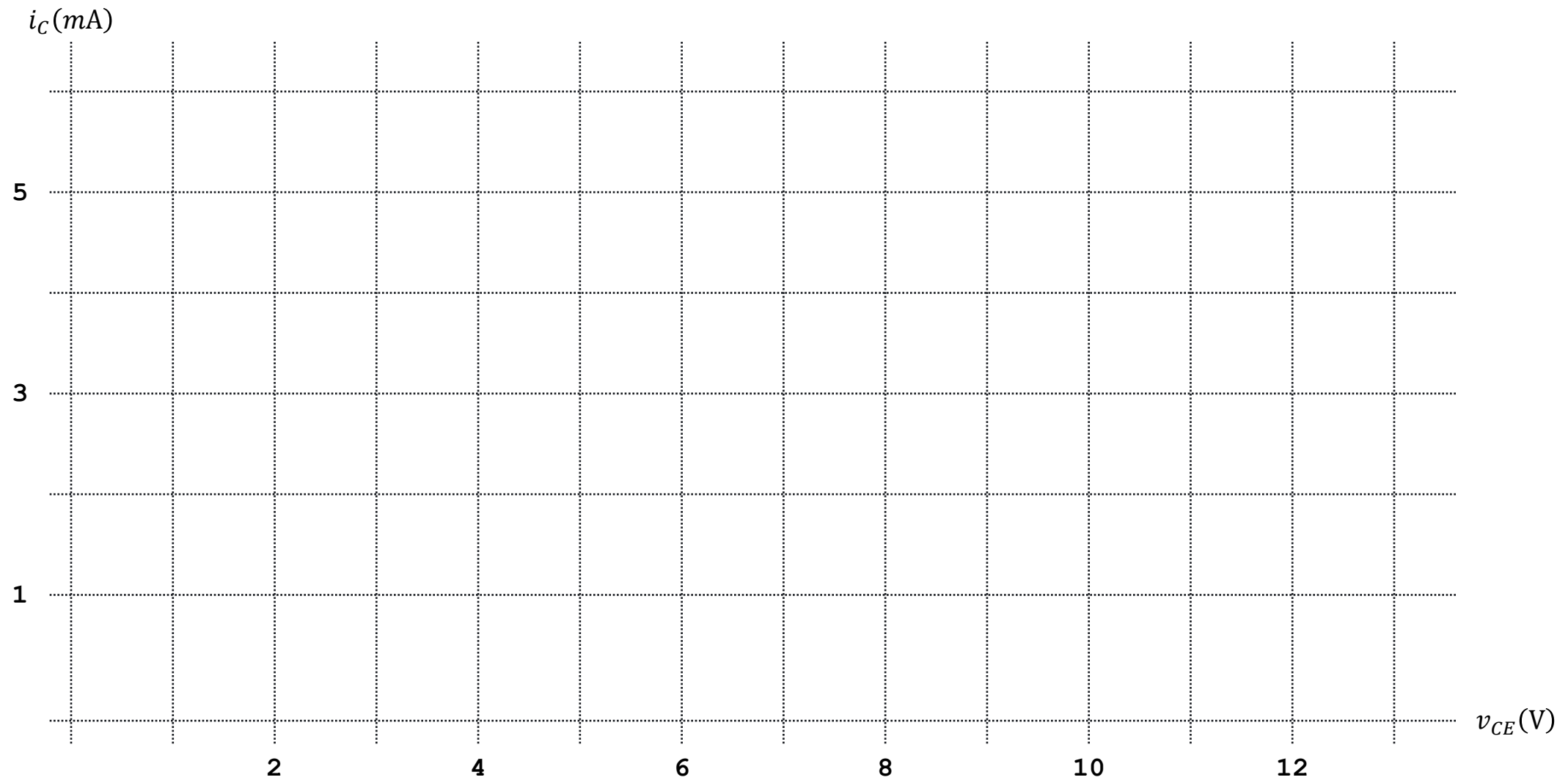
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Solution



# EXERCISE

## Load Line Analysis



# UNSTABLE Q-POINT

Bias	$\beta$	$i_B(\mu A)$	$i_C(mA)$	$v_{CE}(V)$	$\% \Delta v_{CE}$
Fixed-Bias					
Emitter-Stabilized					
Voltage-Divider Bias					



# LABORATORY

