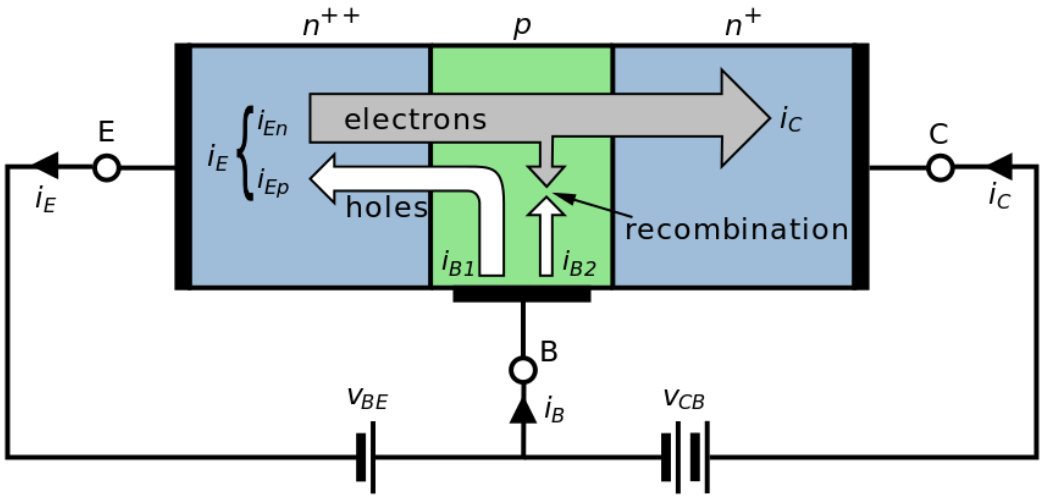
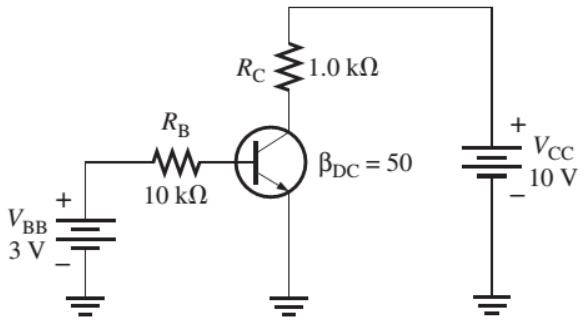
CO2015

Exercise on Bipolar Junction Transistor (NPN)



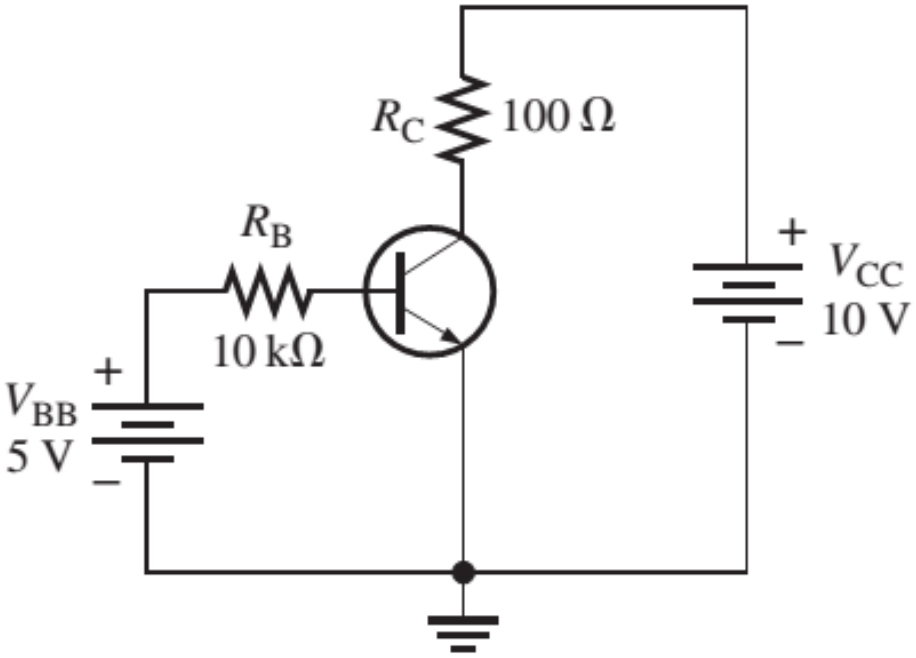


DCE

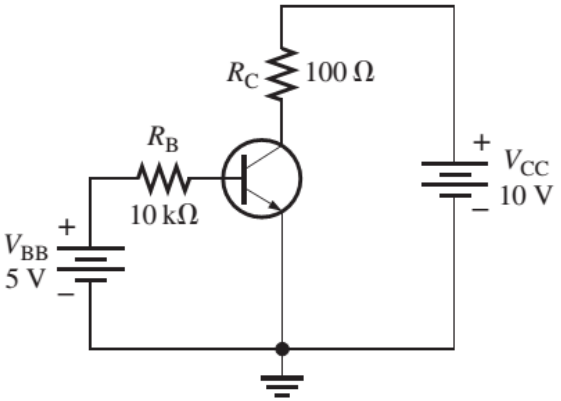
DEPT. OF COMPUTER ENGINEERING

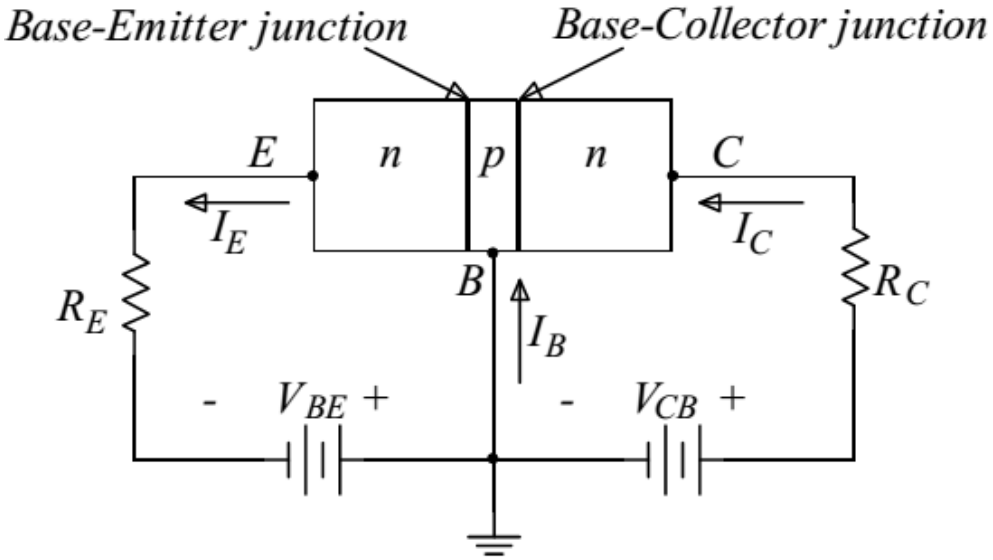
BJT Operation Modes

- $I_B = 0$: Cut-off mode
- V_B is increased (higher than 0.7V), I_B is increased:
  - $I_C = \boldsymbol{\beta_{DC}} I_B$
  - Amplifier mode (Active mode)
  - V_C is increased
- $V_C = V_{CC} - V_{CE}$
  - Saturation mode
  - V_{CE} is small (0.2V)



BJT in Amplifier Mode



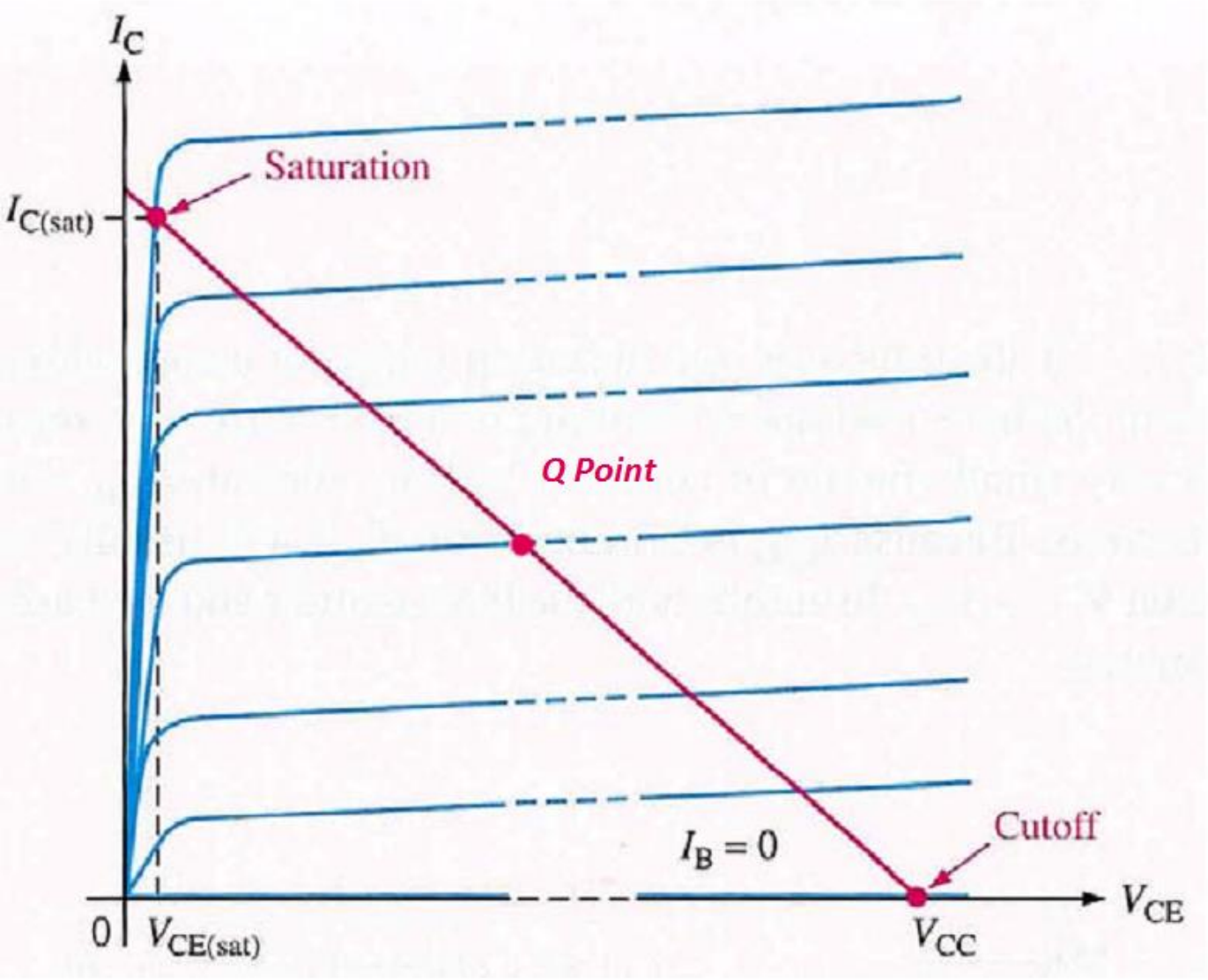


$$I_E = I_C + I_B$$

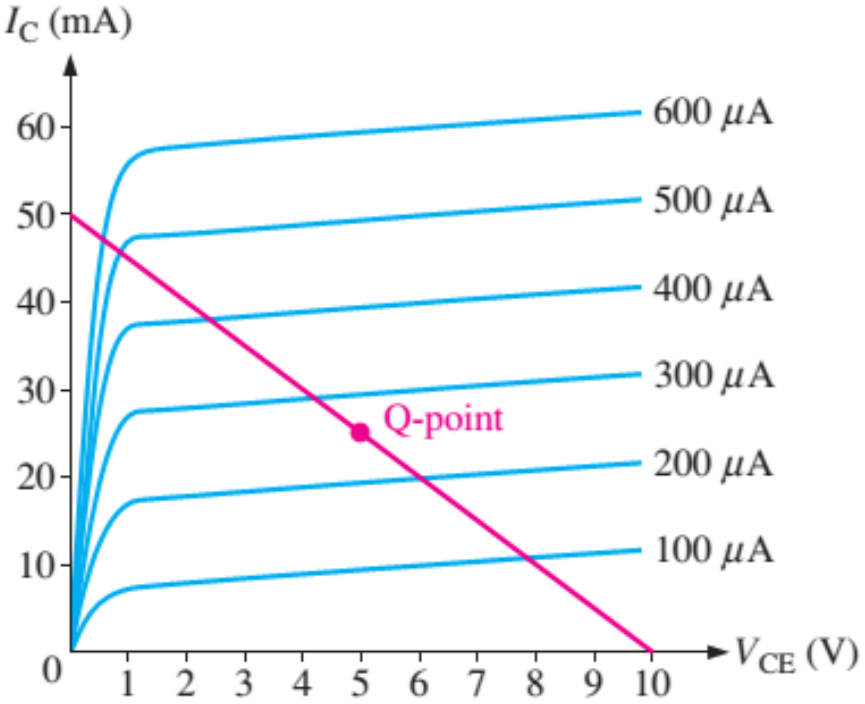
$$\beta_{DC} = \frac{I_C}{I_B}$$

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

DC Load on I-V Curve



Example

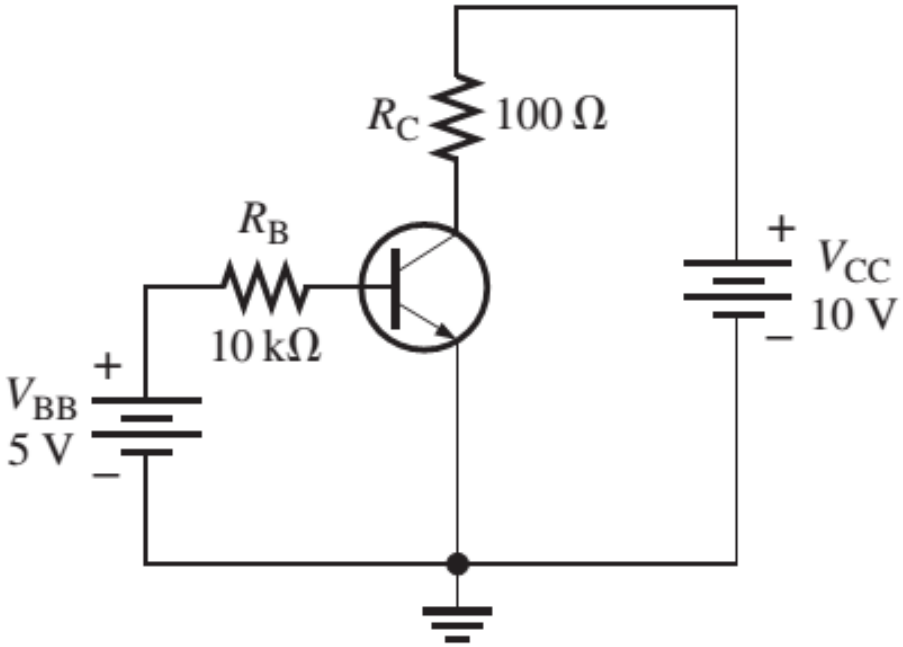


- Determine I_C(Sat)
- Determine β_{DC}
- *I_B, I_C and V_{CE} at Q point*

Answer

- IC (Sat) = 50 (mA)
- β_{DC} = 10mA/ 100muA = 100
- At Q-point:
  - IC = 25 (mA)
  - VCE = 5 (V)
  - IB = 0.25 (mA)

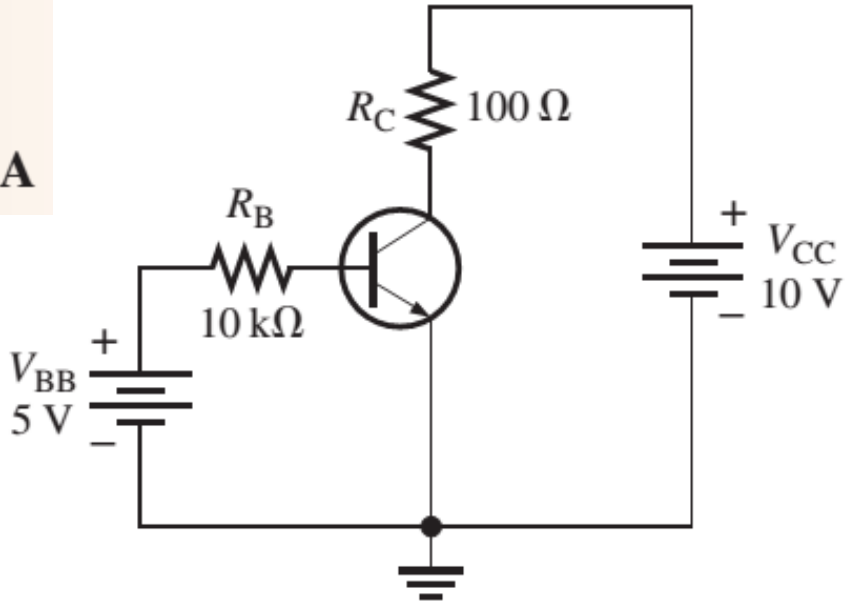
- Determine I_B ,I_C ,I_E ,V_{BE} ,V_{CE} and V_{CB} for the given circuit when $\beta_{DC} = 150$



$$I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{5\,\text{V} - 0.7\,\text{V}}{10\,\text{k}\Omega} = \mathbf{430\ \mu A}$$

$$I_C = \beta_{DC} I_B = (150)(430\,\mu\text{A}) = \mathbf{64.5\ mA}$$

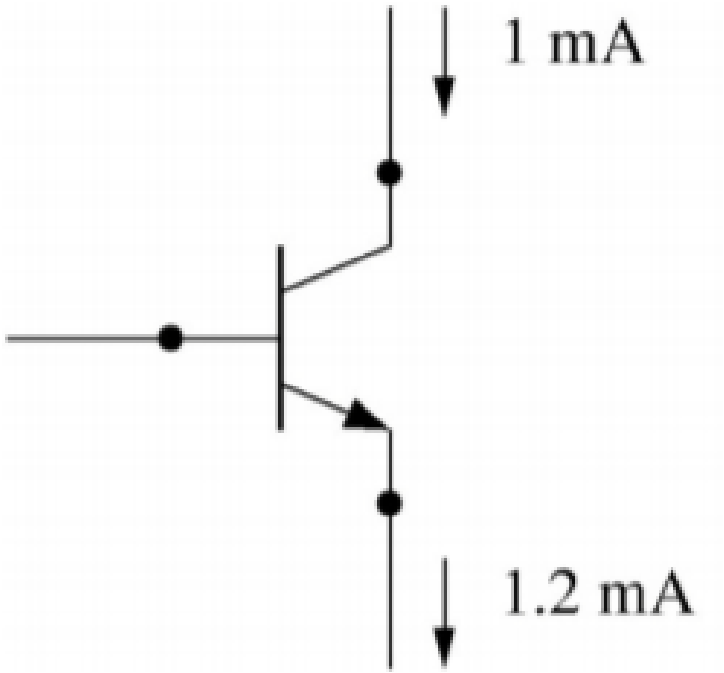
$$I_E = I_C + I_B = 64.5\,\text{mA} + 430\,\mu\text{A} = \mathbf{64.9\ mA}$$



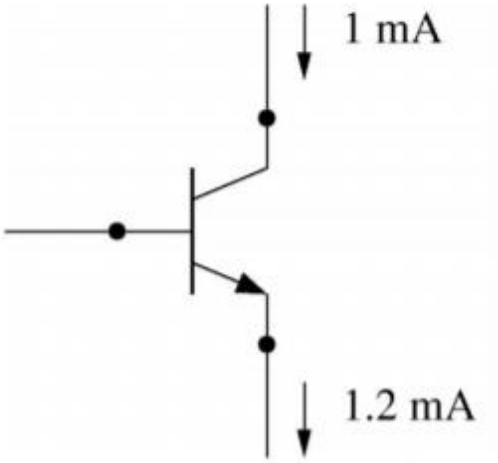
$$V_{CE} = V_{CC} - I_C R_C = 10\,\text{V} - (64.5\,\text{mA})(100\,\Omega) = 10\,\text{V} - 6.45\,\text{V} = \mathbf{3.55\ V}$$

$$V_{CB} = V_{CE} - V_{BE} = 3.55\,\text{V} - 0.7\,\text{V} = \mathbf{2.85\ V}$$

- Find state of transistor (cut-off, amplifier or saturation) and its currents/voltages



Answer



$i_C = 1\ \text{mA} > 0$: BJT is NOT in cut-off

$i_E = 1.2\ \text{mA}$

$i_B = i_E - i_C = 0.2\ \text{mA}$

$i_C / i_B = 1/0.2 = 5 < \beta_{min}$

BJT is in saturation:

$v_{CE} = V_{sat} = 0.2\ \text{V}$

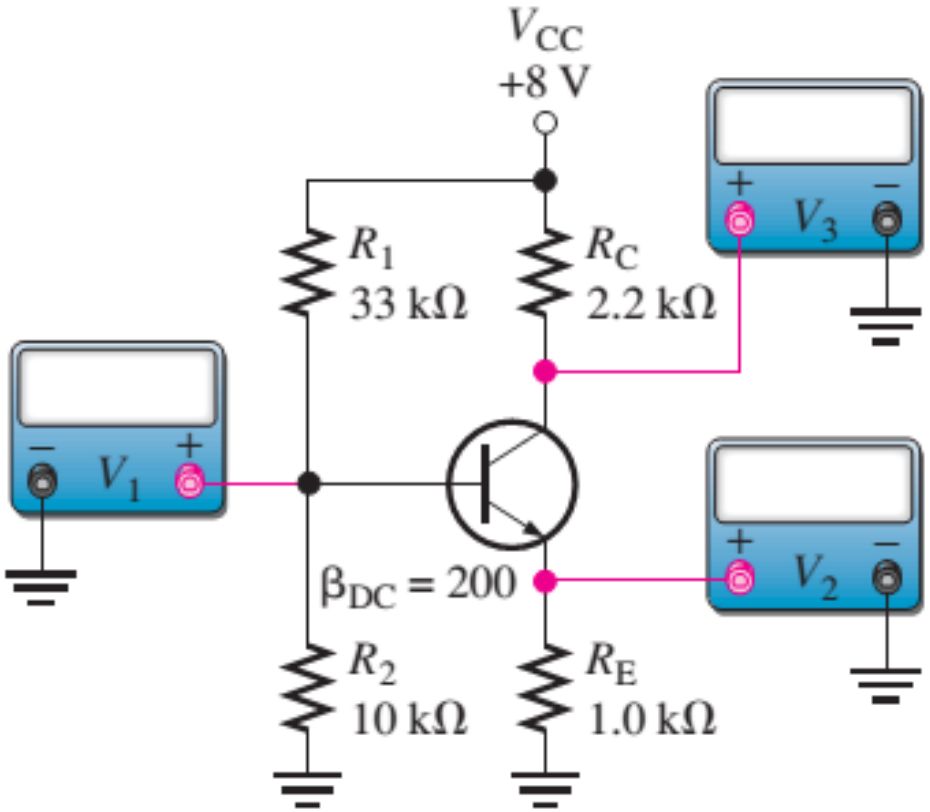
$v_{BE} = V_{D0} = 0.7\ \text{V}$

- When a transistor is used as a switch, it is stable in which two distinct regions?
  - saturation and active
  - active and cutoff
  - saturation and cutoff
  - none of the above

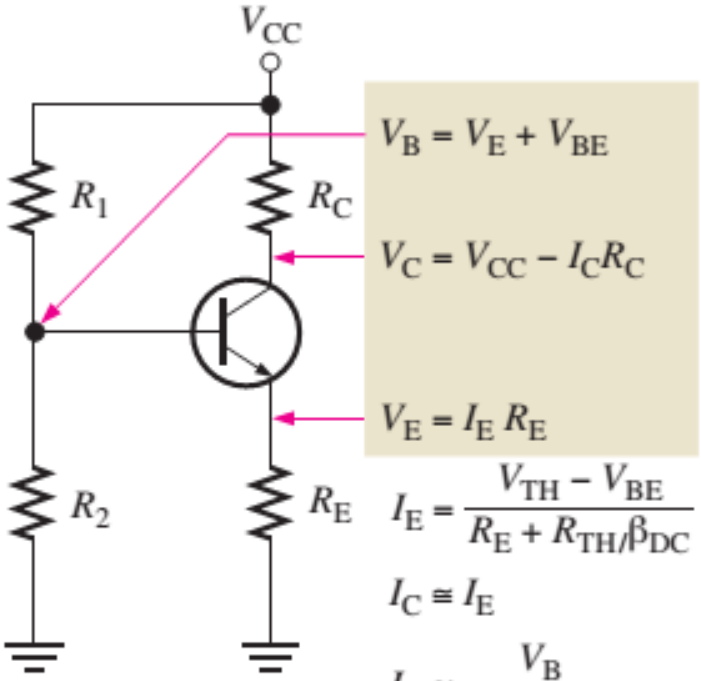
- For a silicon transistor, when a base-emitter junction is forward-biased, it has a nominal voltage drop of
  - 0.7
  - 0.3
  - 0.2
  - V_{CC}

- A certain BJT has I_B = 167uA, I_C = 15mA, the amplifier DC factor is:
  - 15
  - 167
  - 90
  - All are not correct

Exercise



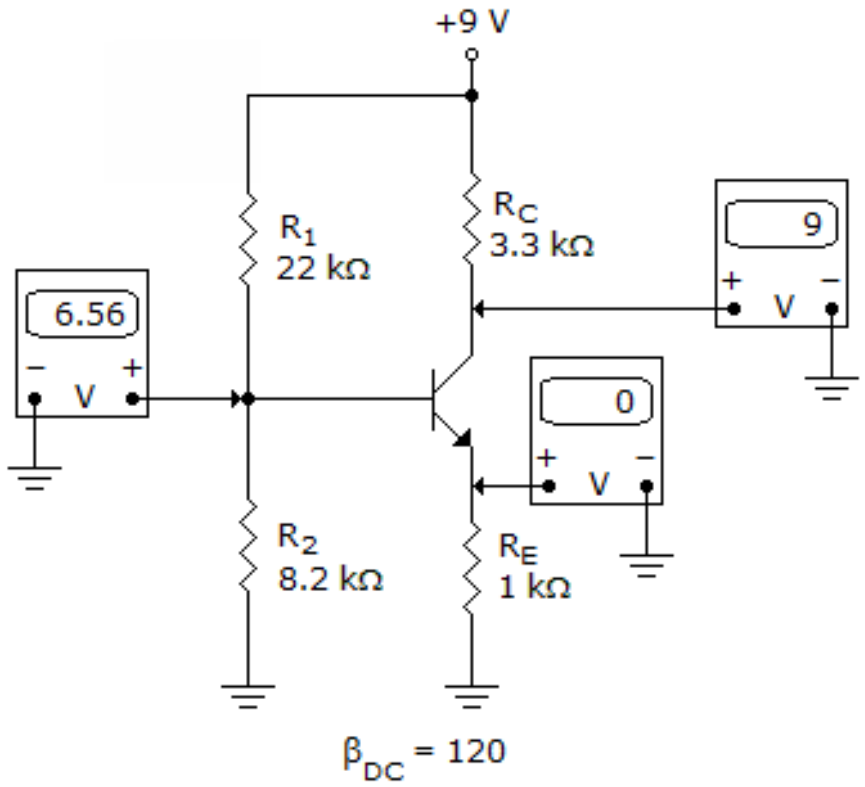
- Determine values on V1, V2, V3



$$R_{IN(BASE)} = V_B/I_B = V_B/(I_E/\beta_{DC})$$

$$V_{TH} = \left(\frac{R_2}{R_1 + R_2}\right)V_{CC} \quad R_{TH} = \frac{R_1 R_2}{R_1 + R_2}$$

- Refer to the given figure. The most probable cause of trouble, if any, from these voltage measurements is



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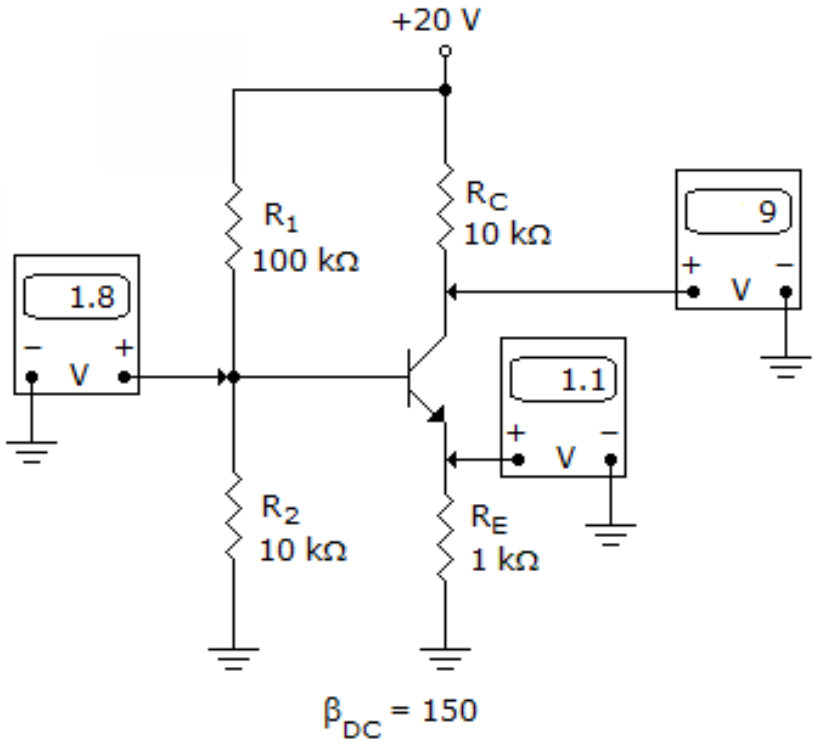
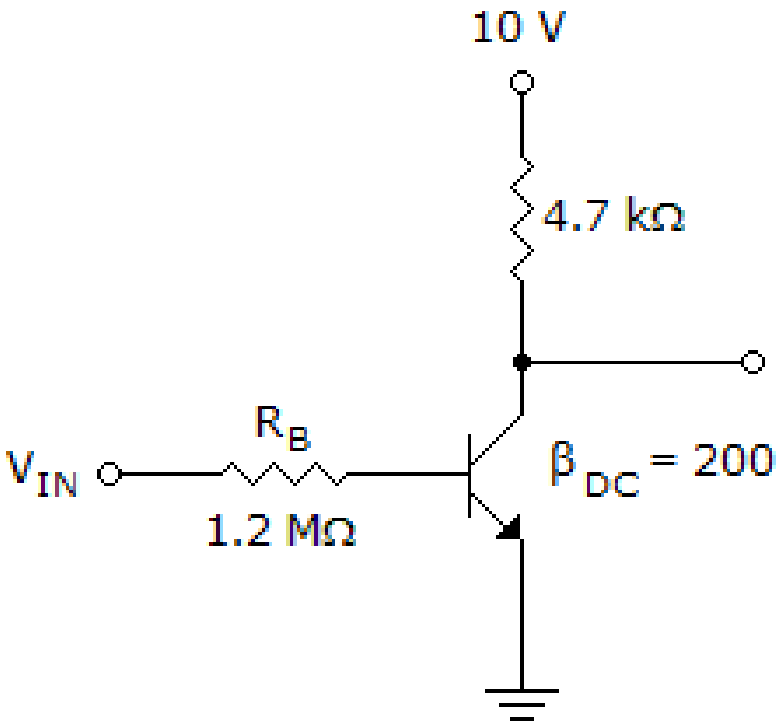
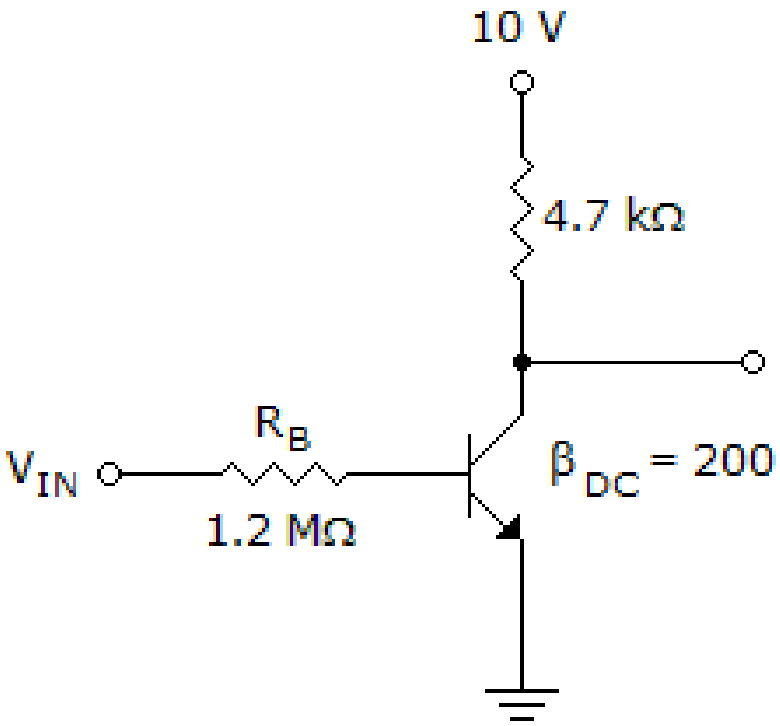


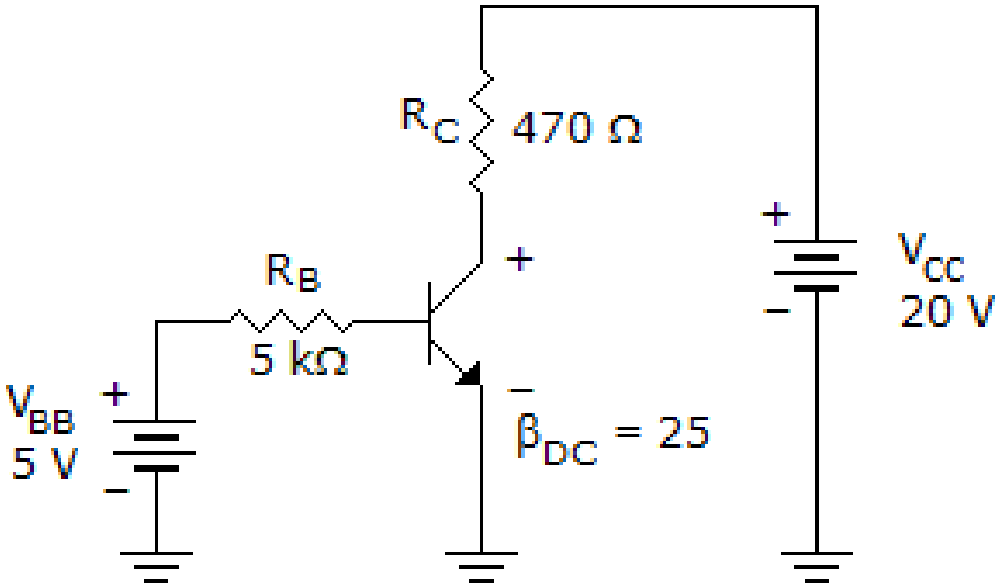
- Refer to this figure. If $V_{CE} = 0.2$ V, $I_{C(sat)}$ is

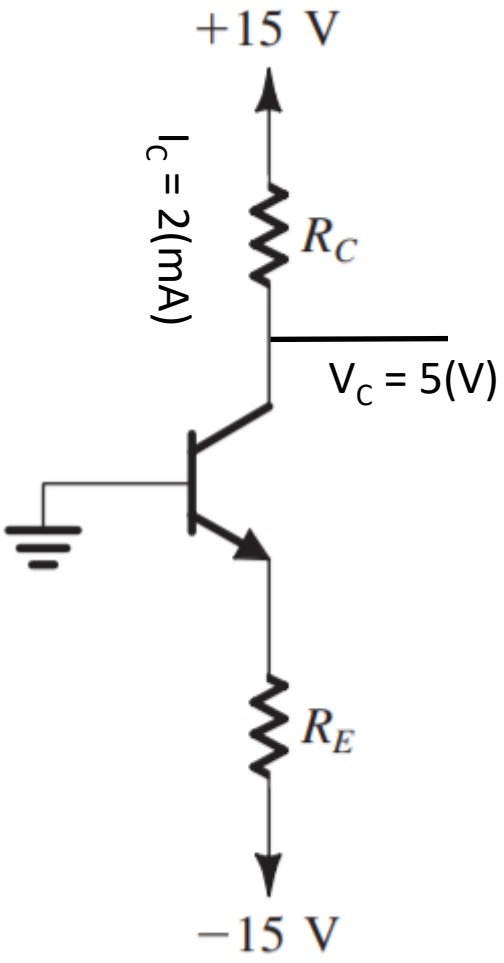


- Refer to this figure. Determine the minimum value of I_B that will produce saturation ($V_{CE}(sat) = 0.2V$).

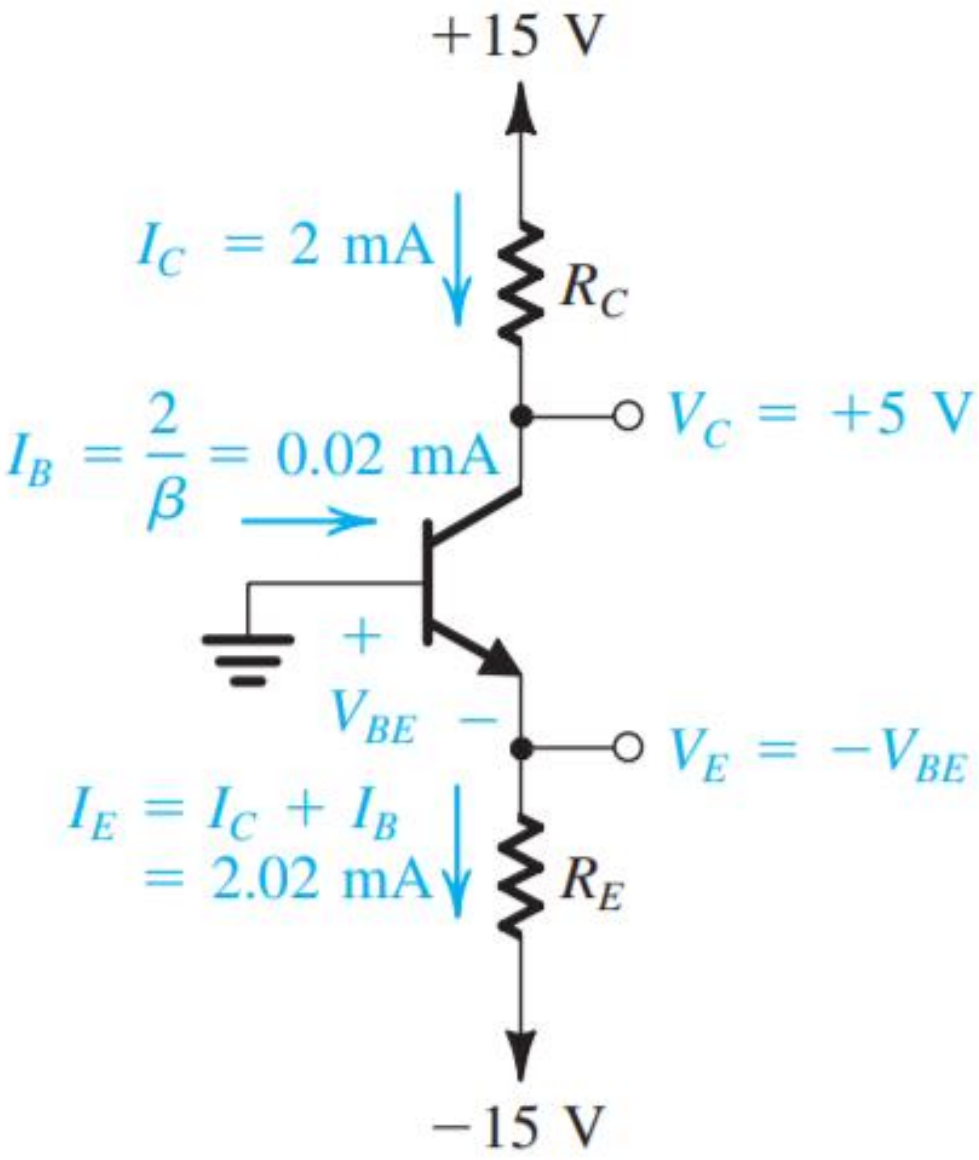


- Refer to this figure. The value of V_{BC} is

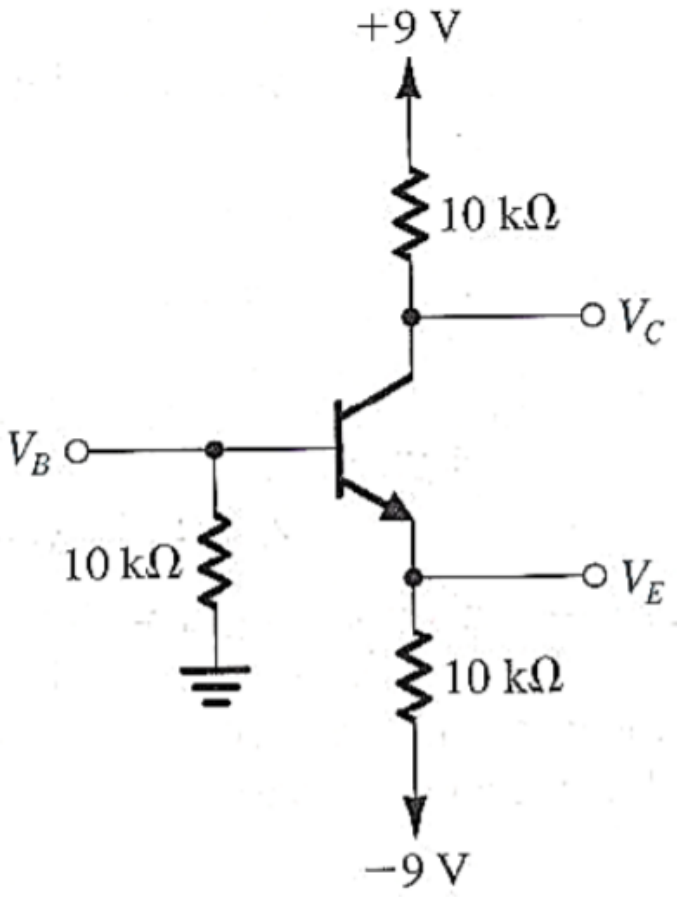




- Determine R_C, R_E
- $V_C = 5V$, $I_C = 2mA$
- $\boldsymbol{\beta}_{DC} = 100$


+15 V
$I_C = 2$ mA
R_C
$I_B = \frac{2}{\beta} = 0.02$ mA
$V_C = +5$ V
+
V_{BE}
−
$V_E = -V_{BE}$
$I_E = I_C + I_B$
$= 2.02$ mA
R_E
−15 V

- V_B = -1.5V
- Calculate I_B, I_C, I_E



Midterm (60 mins – Closed Book)

- 28/03/2019
- Multichoice + Written

- Chapter 1: Basic Electronic Components
  - Deterimine the resistor values (4-band colors, 5-band colors)
  - LEDs connectors (Serial + Parallel)

- Chapter 2: Diode
  - Diode Principles and Models
  - Applications using Diodes

- Chapter 3: BJT (npn)
  - Amplifier Coefficient, Applications
  - Cutoff, Saturation and Amplifier modes
  - Vbe = 0.7 (for default)