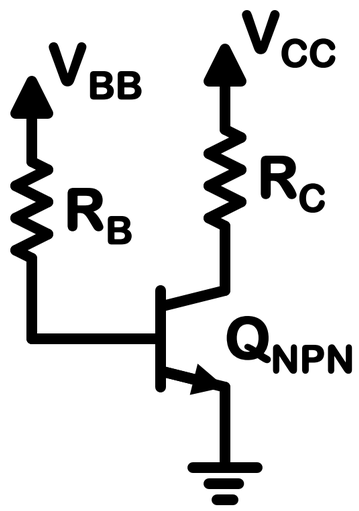
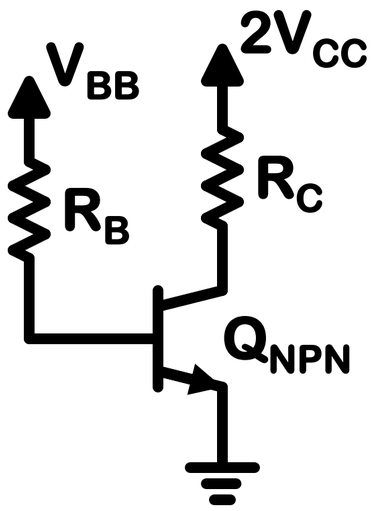
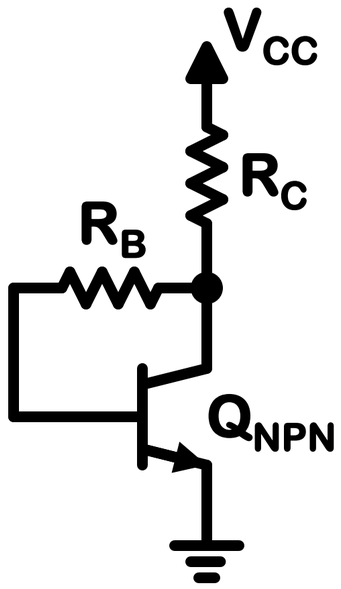


A: Saturation

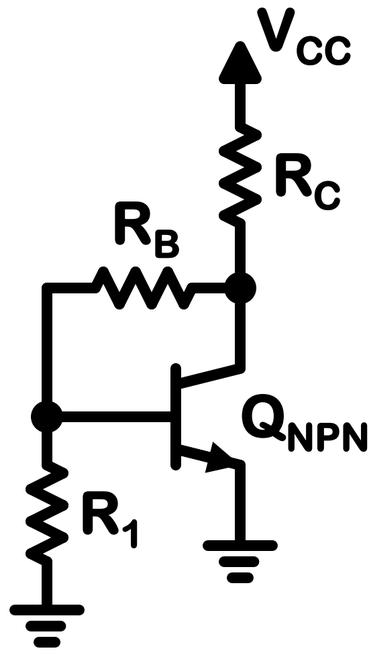


B: Active



C: Active

$(4/3)*V_{CC}$



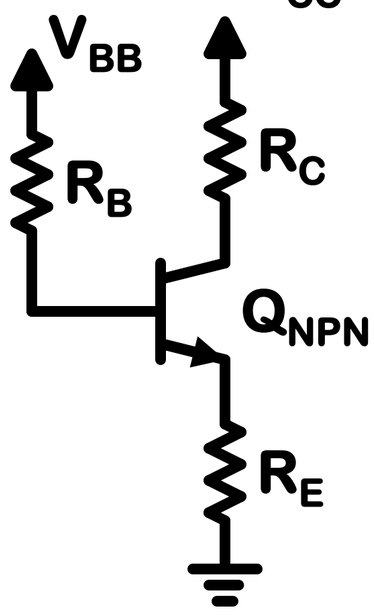
D: Active

$(4/3)*V_{CC}$

$V_{CC} = 6V$
$V_{BB} = 4V$
$R_B = 10k\Omega$
$R_C = 500\Omega$
$R_E = 200\Omega$
$R_1 = 10k\Omega$
$\beta = 50$

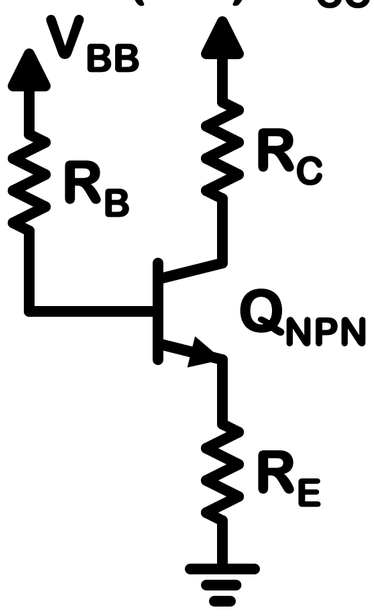
- Find the collector current, i_C, for each device.
- Verify the mode which is given for each circuit.
- Draw PNP equivalent.

$0.5V_{CC}$

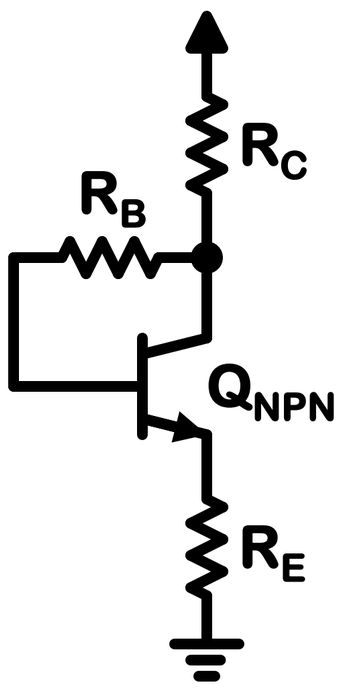


E: Saturation

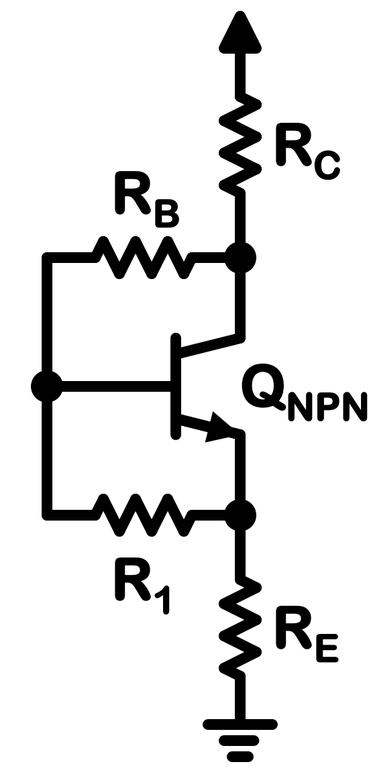
$(4/3)*V_{CC}$



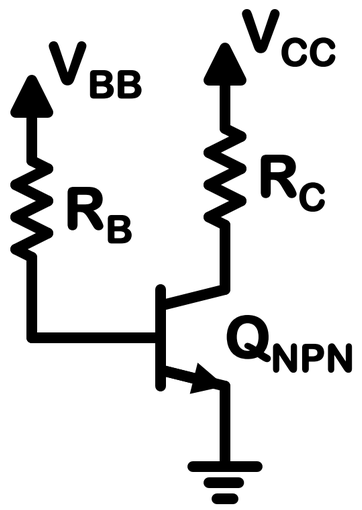
F: Active



G: Active



H: Active

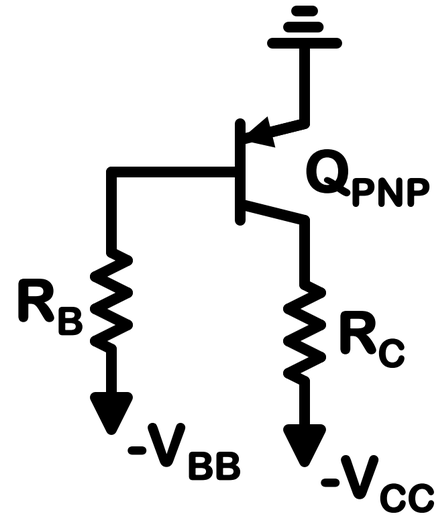


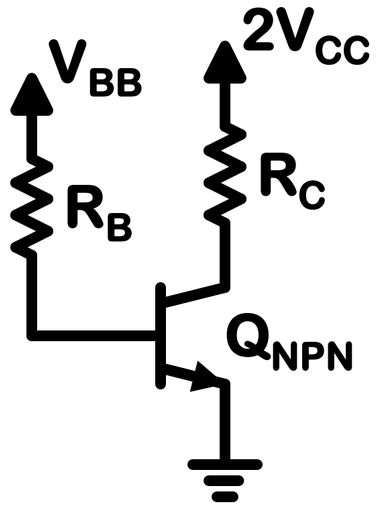
1. Saturation

2. Enforce (device equation)
$v_{BE} = 0.7V, v_{CE} = 0.2V$

3. Solve
$i_B = (4.0 – 0.7)/10k = 0.33mA$
$i_C = (6.0 – 0.2)/500 = 11.6mA$

4. Check
$i_C/i_B = 11.6/0.33 = 35 < 50$



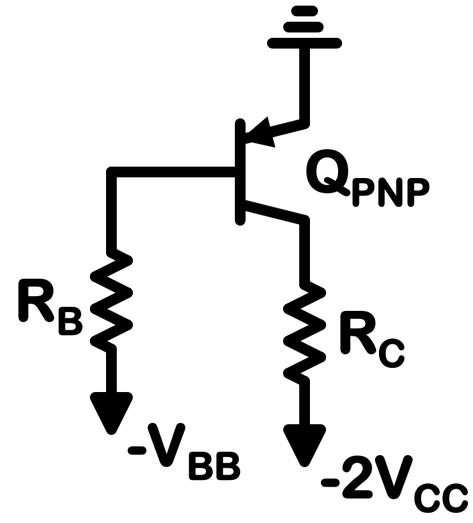


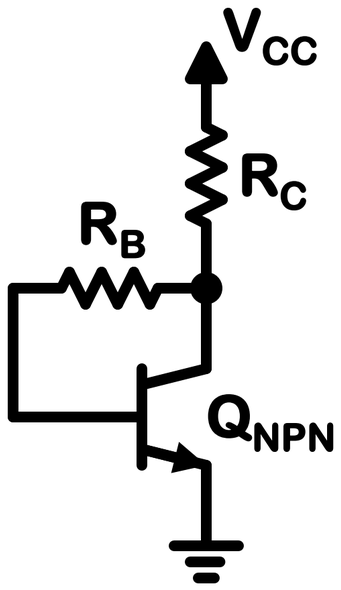
1. Active

2. Enforce (device equation)
$v_{BE} = 0.7V$, $i_C = \beta \cdot i_B$

3. Solve
$i_B = (4.0 - 0.7)/10k = 0.33mA$
$i_C = 50 i_B = 16.5mA$

4. Check
$V_{CE} = 12 - 500*0.0165 = 3.75V > 0.2V$



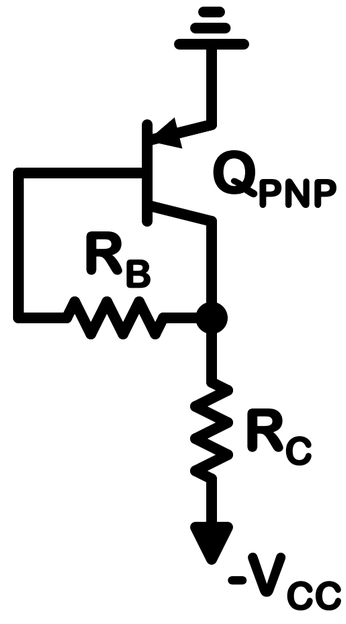


1. Active

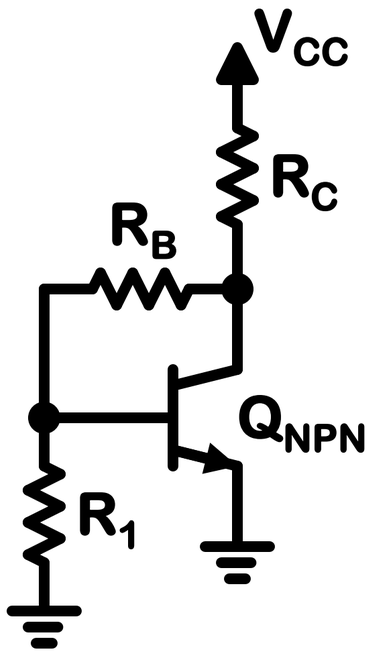
2. Enforce (device equation)
$v_{BE} = 0.7V$, $i_C = \beta \cdot i_B$

3. Solve
$6 - 500i_E - 10000i_B - 0.7 = 0$
$6 - 500(50+1)i_B - 10000i_B - 0.7 = 0$
$i_B = (6-0.7)/(500(50+1) + 10000)$

$i_B = 0.15$ mA
$i_C = 7.46$ mA



4. Check
$V_{CE} = 6 - 500*0.00761 = 2.19V > 0.2V$



1. Active

2. Enforce (device equation)

$v_{BE} = 0.7V$, $i_C = \beta \cdot i_B$

3. Solve

$6 - 500(i_E + 0.7/10000) - 10000(i_B + 0.7/10000) - 0.7 = 0$

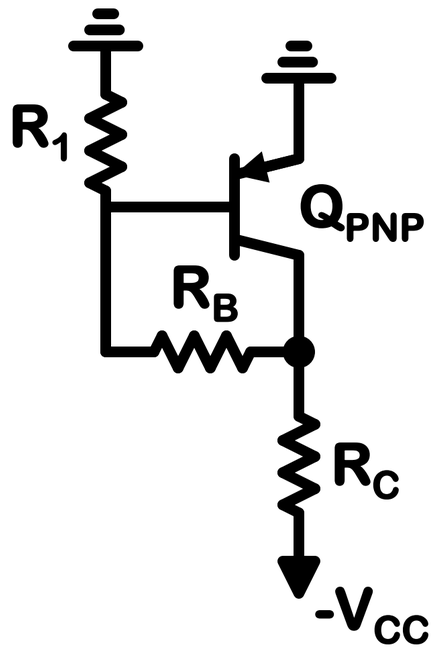
$6 - 500((50+1)i_B + 0.00007) - 10000(i_B + 0.00007) - 0.7 = 0$

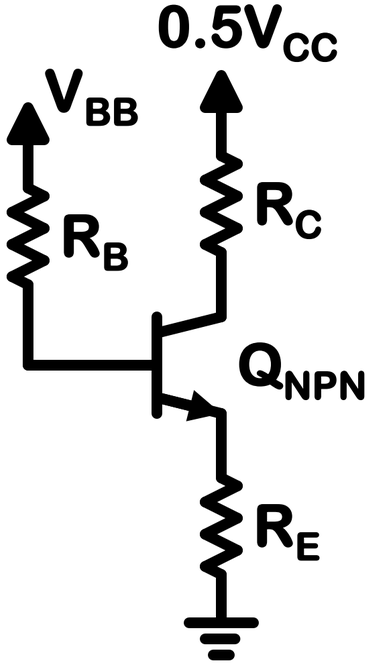
$i_B = (6 - 0.7 - 10500*.00007)/(500(51) + 10000) = 0.129\ mA$

$i_C = 6.43mA$

4. Check

$V_{CE} = 6 - 500*0.00656 = 2.72V > 0.2V$





1. Saturation

2. Enforce (device equation)

$v_{BE} = 0.7V, v_{CE} = 0.2V$

3. Solve

$i_E = i_B + i_C$

$v_E/200 = (4-(v_E+0.7))/10000 + (3-(v_E+0.2))/500$

$50v_E = 4 – v_E – 0.7 + 60 – 20v_E – 4$

$71v_E = 59.3$

$v_E = 0.835\ V$

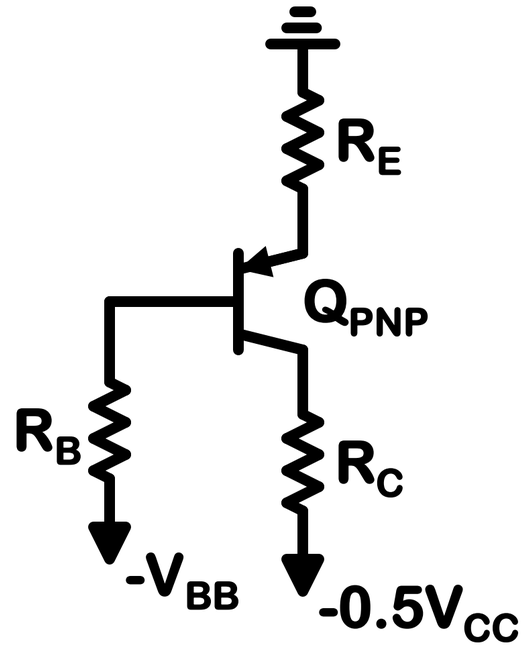
$i_E = 0.835/200 = 4.175\ mA$

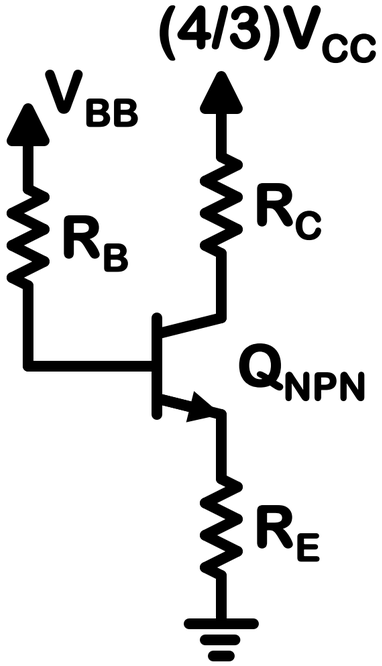
$i_B = (4-(0.835+0.7))/10000 = 0.246\ mA$

$i_C = (3-(0.835+0.2))/500 = 3.93\ mA$

4. Check

$i_C/i_B = 16 < 50$





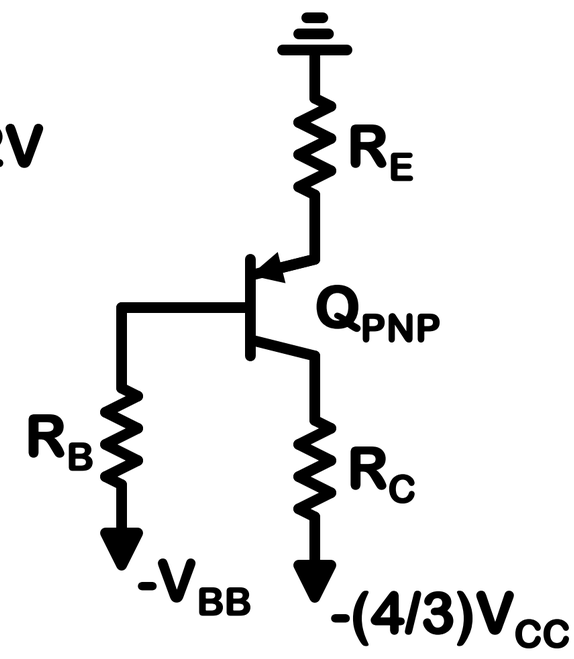
1. Active

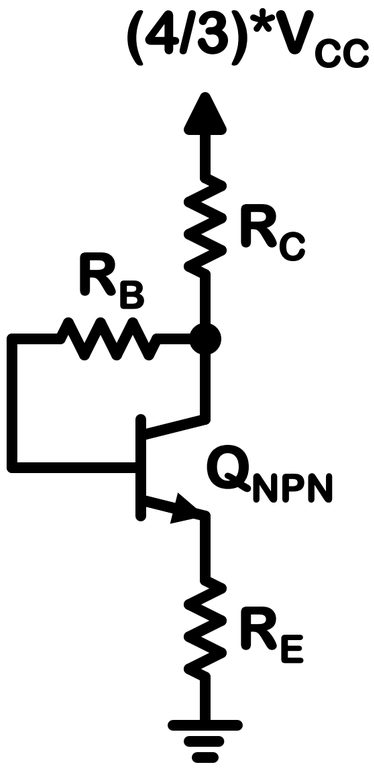
2. Enforce (device equation)
$v_{BE} = 0.7V$, $i_C = \beta \cdot i_B$

3. Solve
$4 - 10000i_B - 0.7 - 200i_E = 0$
$4 - 10000i_B - 0.7 - 200(50+1)i_B = 0$

$i_B = (4-0.7)/(10000 + 200(50+1)) = 0.163$ mA
$i_C = 50*0.163 = 8.168$ mA
iE = 8.332 mA

4. Check
$v_{CE} = 8-8.168m*500-8.332m*200 = 2.25V > 0.2V$





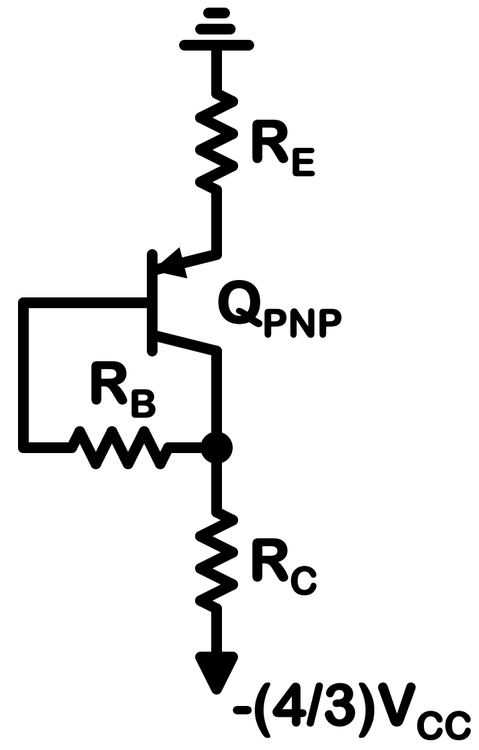
1. Active

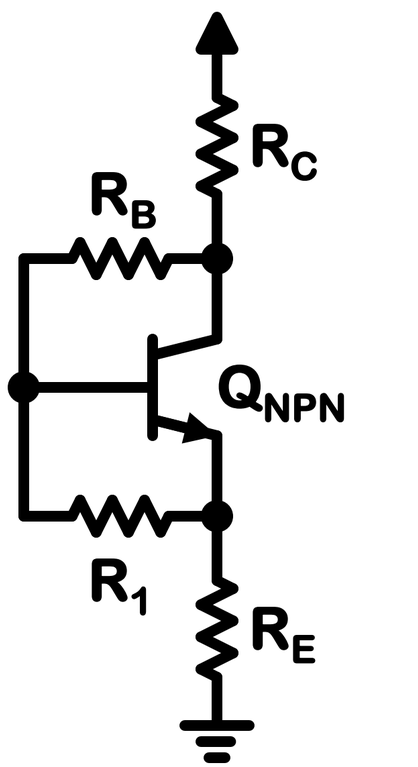
2. Enforce (device equation)
$v_{BE} = 0.7V$, $i_C = \beta \cdot i_B$

3. Solve
$8 - (500+200)i_E - 10000i_B - 0.7 = 0$
$8 - 700(50+1)i_B - 10000i_B - 0.7 = 0$
$i_B = (8-0.7)/(700(50+1) + 10000)$

$i_B = 0.16$ mA
$i_C = 7.99$ mA

4. Check
$V_{CE} = 8 - 700*0.00815 = 2.3V > 0.2V$





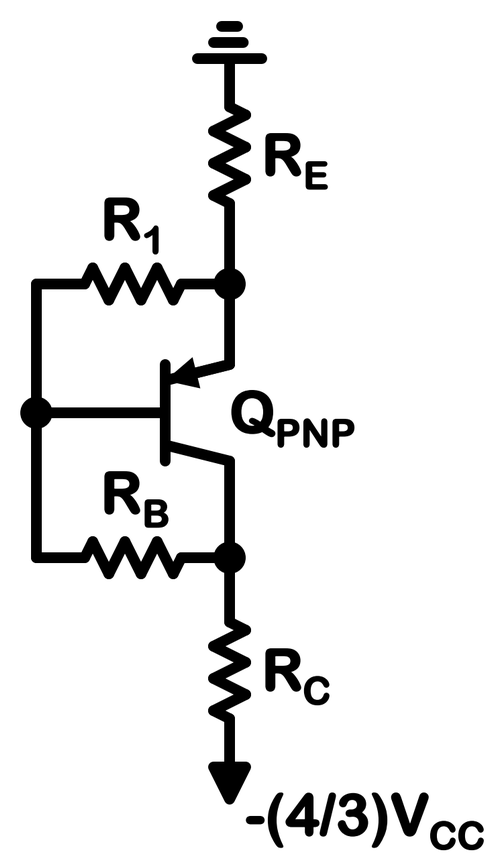
1. Active

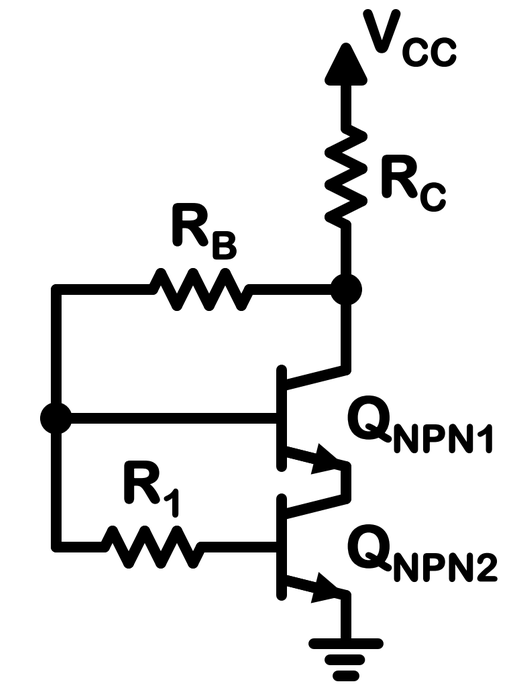
2. Enforce (device equation)
$v_{BE} = 0.7V$, $i_C = \beta \cdot i_B$

3. Solve
$8 - 700(i_E + 0.7/10000) - 10000(i_B + 0.7/10000) - 0.7 = 0$
$8 - 700((50+1)i_B + 0.00007) - 10000(i_B + 0.00007) - 0.7 = 0$

$i_B = (8 - 0.7 - 10700*.00007)/(700(51) + 10000) = 0.143$ mA
$i_C = 7.167$mA

4. Check
$v_{CE} = 8 - 700*0.00731 = 2.883V > 0.2$





1. Active & Saturation

2. Enforce (device equation)

$v_{BE1} = 0.7V$, $i_{C1} = 50i_{B1}$

$v_{BE2} = 0.7V$, $v_{CE2} = 0.2V$

3. Solve

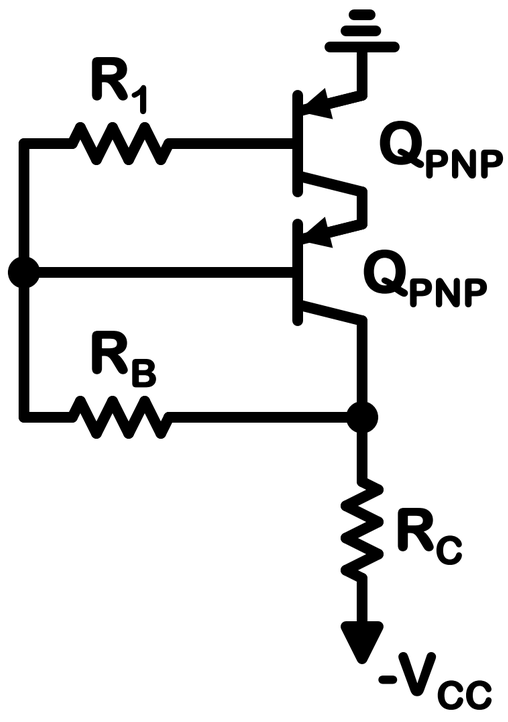
$v_{B2}=0.7V$, $v_{C2}=v_{E1}=0.2V$, $v_{B1}=0.9V$

$i_{B2} = 0.2/10000 = 0.00002mA$

$6 – 500(i_{E1} + .00002) – 10000(i_{B1}+ .00002) = 0.9V$

$6 – 500(i_{E1} + .00002) – 10000(i_{E1}/51+.00002) = 0.9V$

$6 – 0.9 – 10500*.00002 = (500+10000/51)i_{E1}$



$i_{E1} = 7.025mA$

$i_{B1} = 0.138mA$

$i_{C1} = 6.887mA$

$i_{C2} = i_{E1} = 7.025mA$

$i_{B2} = 0.02mA$

$i_{E2} = 7.045mA$

Check: $v_{CE} = 6 – 500i_{E2} – 0.2 = 2.278 > .2$

$i_{C2}/i_{B2} = 351$ not less than 50 - wrong