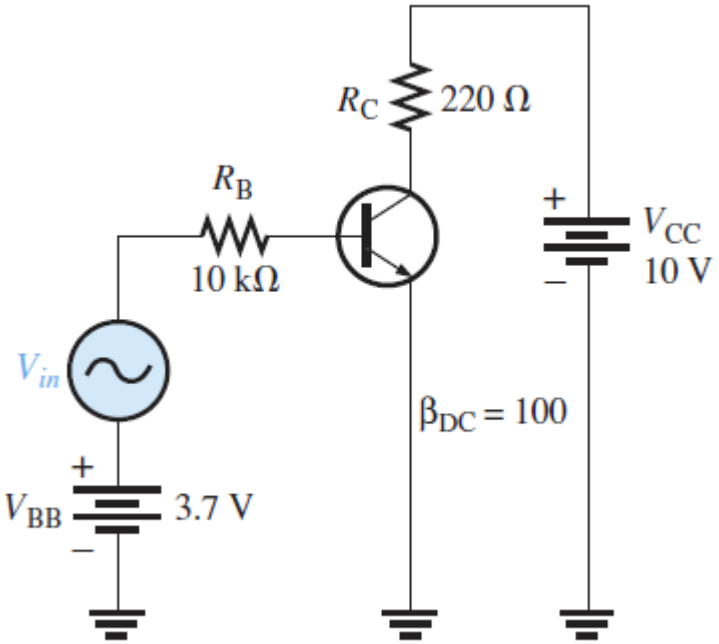
Osnove elektronike
III semestar

POLARIZACIJA POJAČAVAČA

Uprošćen primer pojačavača



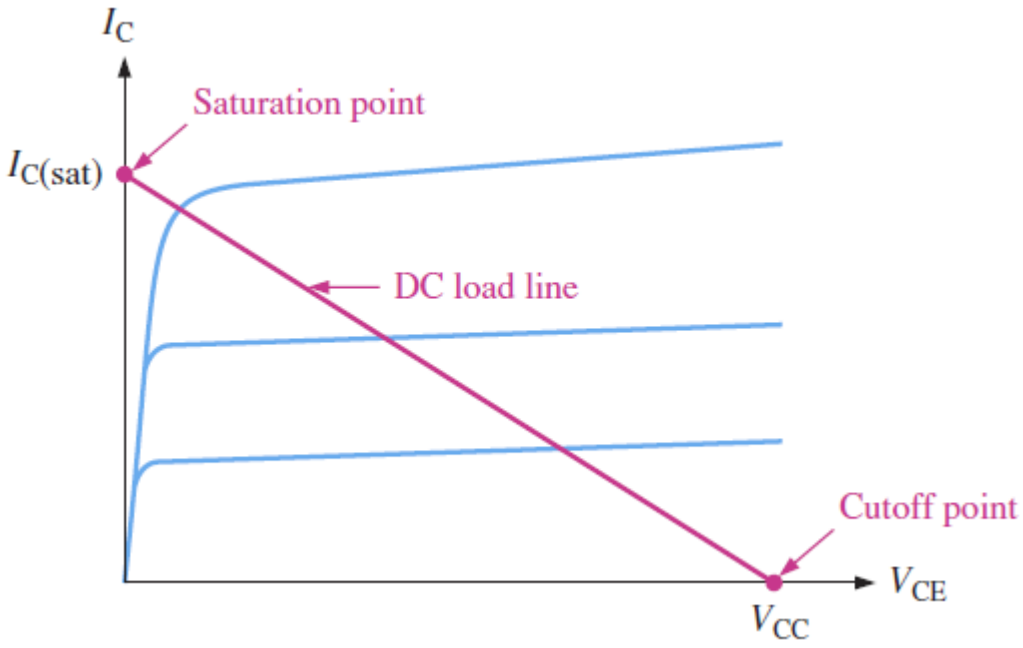
$$I_{BQ} = \frac{V_{BB} - 0.7\ \text{V}}{R_B} = \frac{3.7\ \text{V} - 0.7\ \text{V}}{10\ \text{k}\Omega} = 300\ \mu\text{A}$$

$$I_{CQ} = \beta_{DC} I_{BQ} = (100)(300\ \mu\text{A}) = 30\ \text{mA}$$

$$V_{CEQ} = V_{CC} - I_{CQ} R_C = 10\ \text{V} - (30\ \text{mA})(220\ \Omega) = 3.4\ \text{V}$$

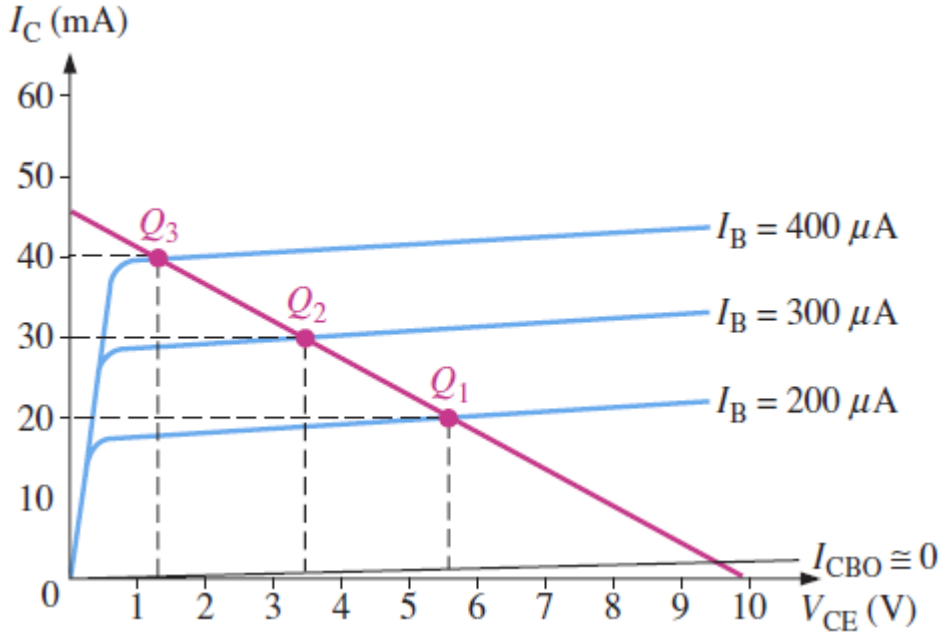
Radna prava pojačavača

$$I_C = \frac{V_{CC} - V_{CE}}{R_C} = \frac{V_{CC}}{R_C} - \frac{V_{CE}}{R_C} = -\frac{V_{CE}}{R_C} + \frac{V_{CC}}{R_C} = -\left(\frac{1}{R_C}\right)V_{CE} + \frac{V_{CC}}{R_C}$$



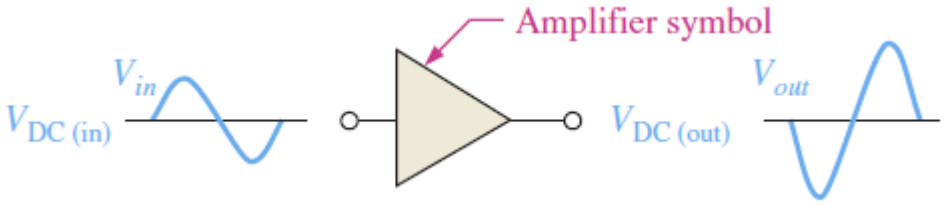
Sve polarizacije pojačavača

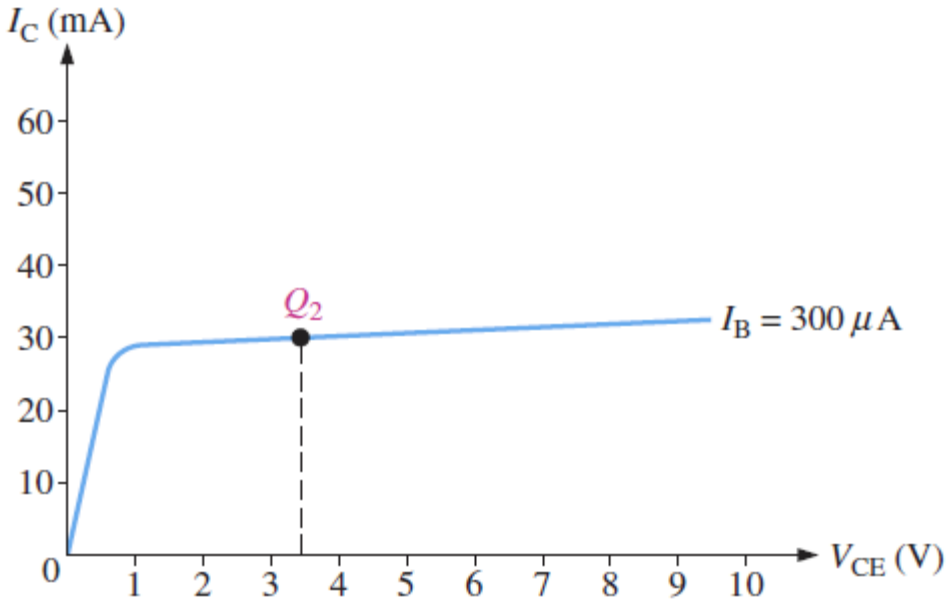
Radna prava pojačavača sa tri primera položaja radne tačke (Q2 za optimalnu, Q1 za previsoku i Q3 za prenisku).



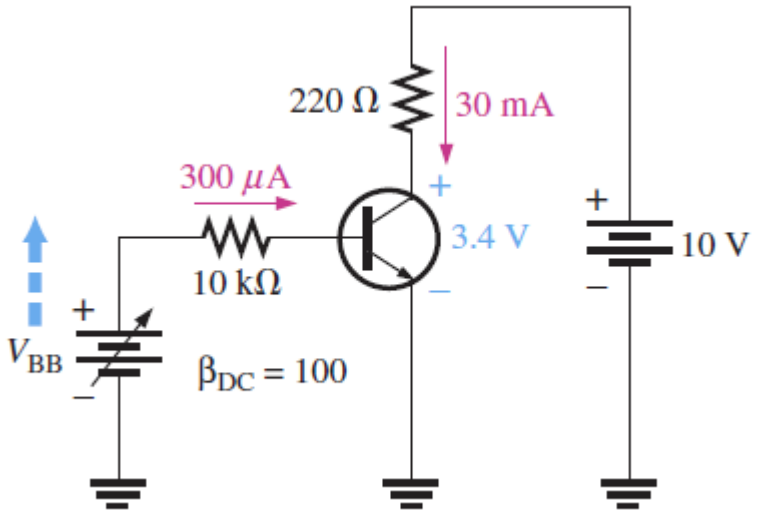
Q2 optimalna polarizacija pojačavača

Pojačavači se najčešće polarišu za postizanje maksimalne amplitude neizobličenog sinusoidalnog signala na izlazu.





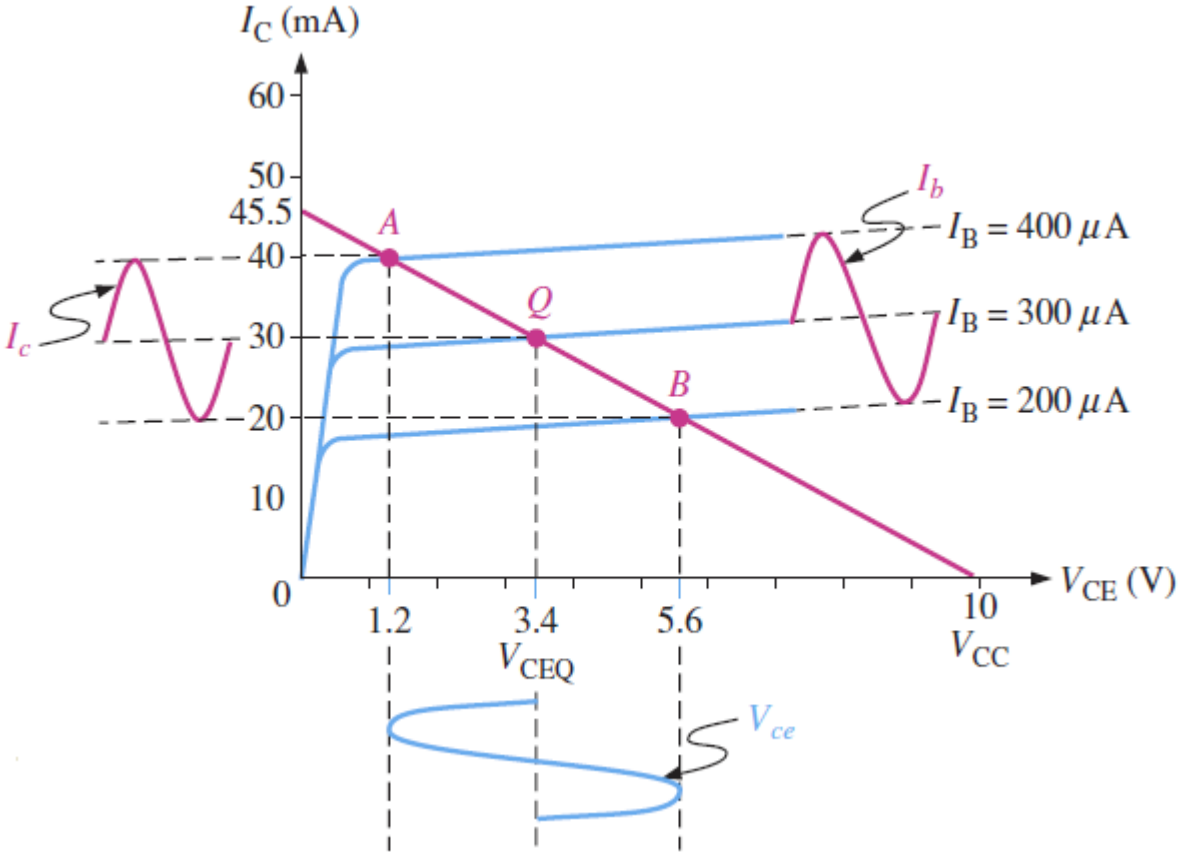
Q2 optimalna polarizacija pojačavača



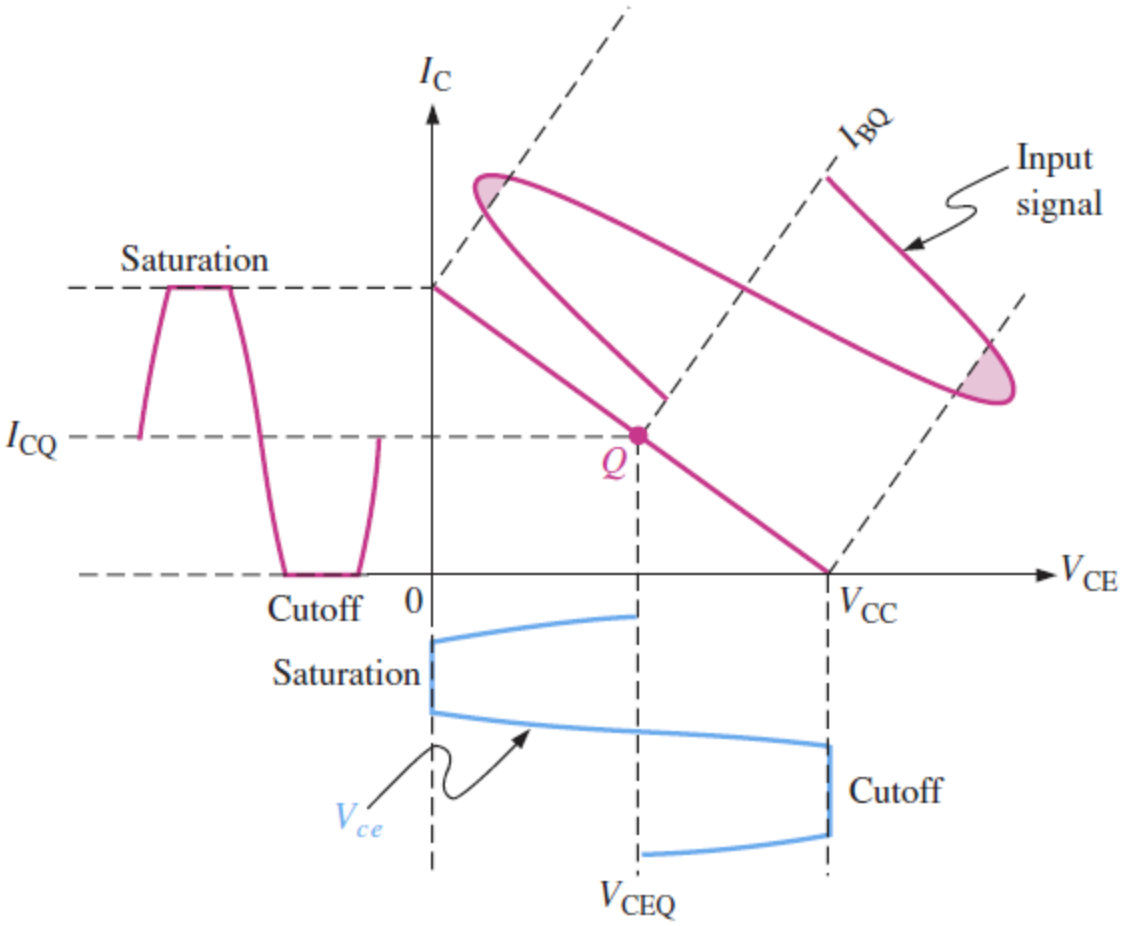
$$V_{CE} = V_{CC} - I_C R_C$$

$$V_{CE} = 10\,\text{V} - (30\,\text{mA})(220\,\Omega) = 10\,\text{V} - 6.6\,\text{V} = 3.4\,\text{V}$$

Q2 optimalna polarizacija pojačavača

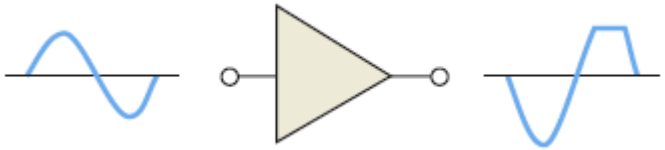


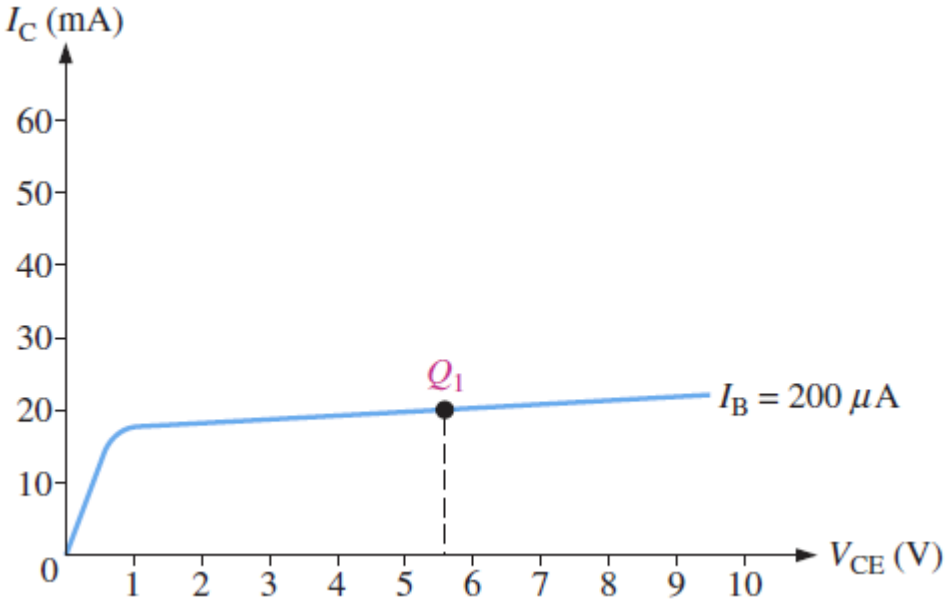
Prevelika amplituda na izlazu



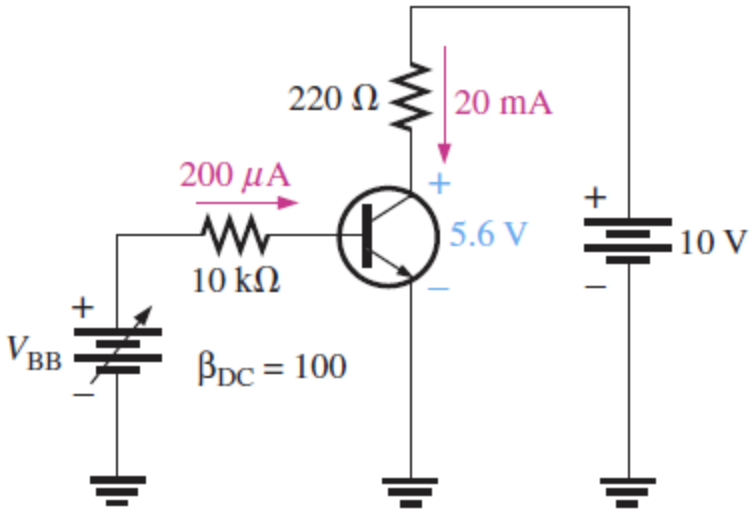
Q1 previsoka polarizacija pojačavača

Preveliki napon u mirnoj radnoj tački na izlazu pojačavača dovodi do ograničenja (odsecanja) amplitude sa gornje strane.



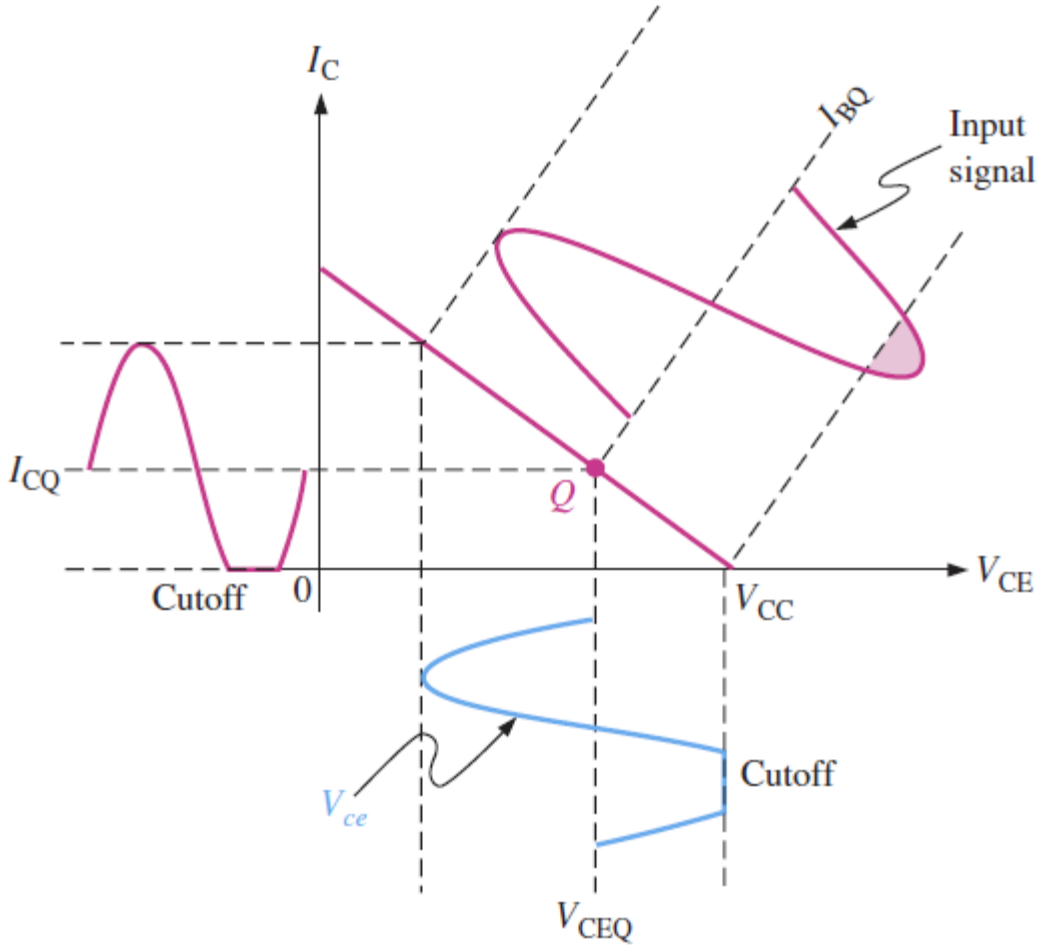


Q1 previsoka polarizacija pojačavača



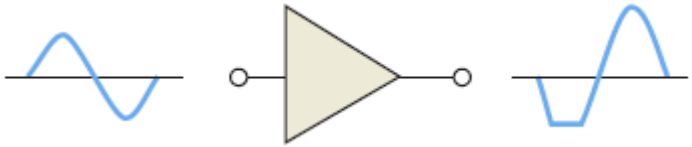
$$V_{CE} = 10\,\text{V} - (20\,\text{mA})(220\,\Omega) = 10\,\text{V} - 4.4\,\text{V} = 5.6\,\text{V}$$

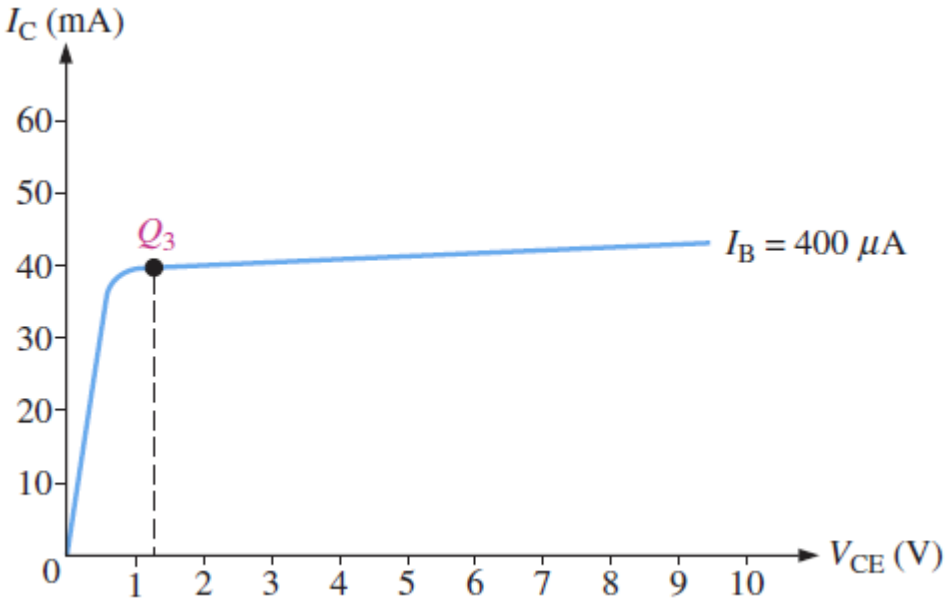
Q1 previsoka polarizacija pojačavača



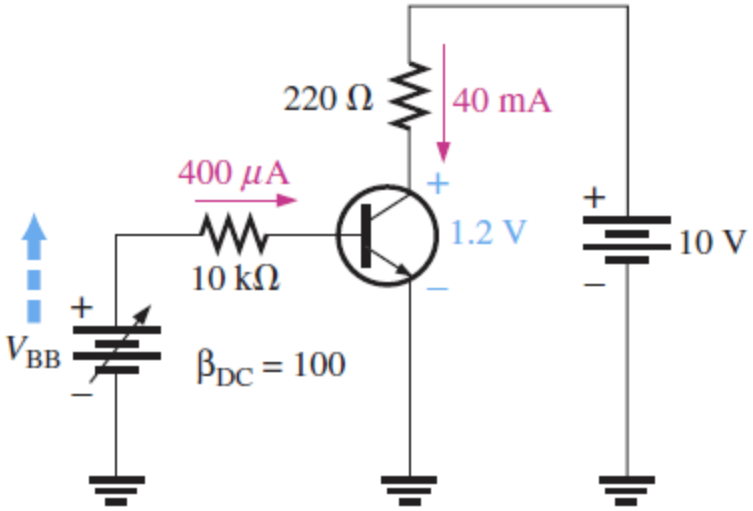
Q3 preniska polarizacija pojačavača

Prenizak napon u mirnoj radnoj tački na izlazu pojačavača dovodi do ograničenja (odsecanja) amplitude sa donje strane.



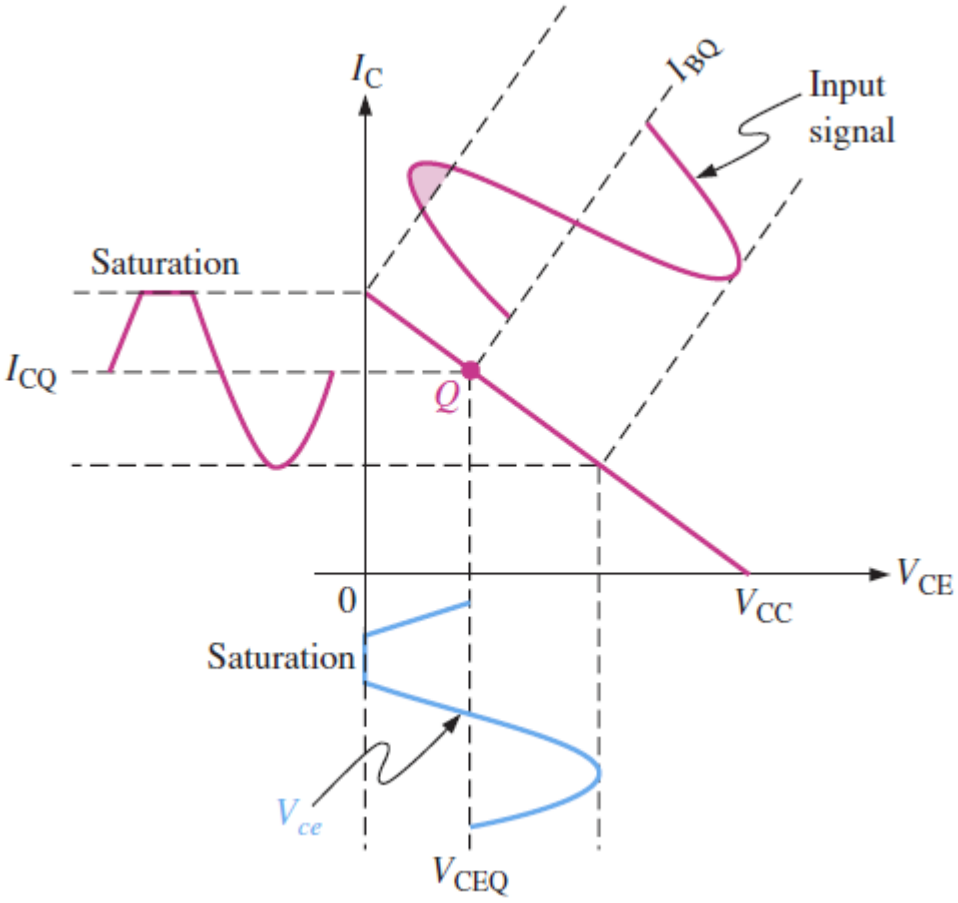


Q3 preniska polarizacija pojačavača

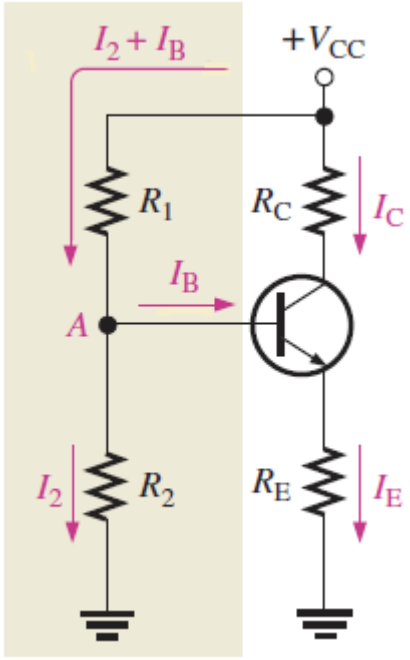


$$V_{CE} = 10\,\text{V} - (40\,\text{mA})(220\,\Omega) = 10\,\text{V} - 8.8\,\text{V} = 1.2\,\text{V}$$

Q3 preniska polarizacija pojačavača



Polarizacija razdelnikom napona i otpornikom u emitoru



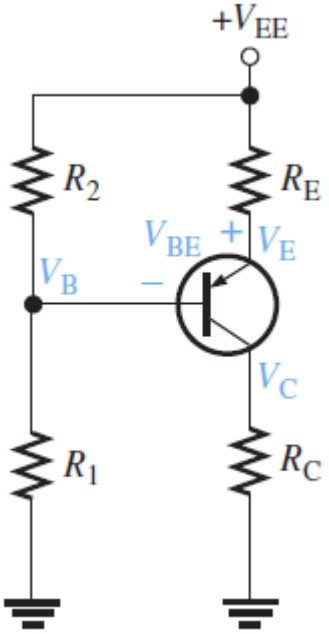
$$V_B \cong \left(\frac{R_2}{R_1 + R_2}\right)V_{CC}$$

$$V_E = V_B - V_{BE}$$

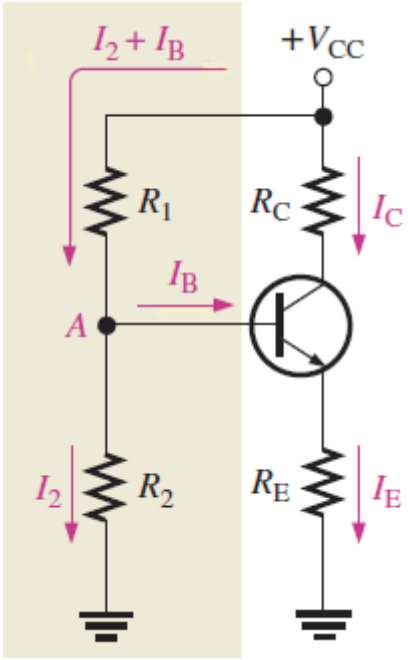
$$I_C \cong I_E = \frac{V_E}{R_E}$$

$$V_C = V_{CC} - I_C R_C$$

$$V_{CE} = V_C - V_E$$

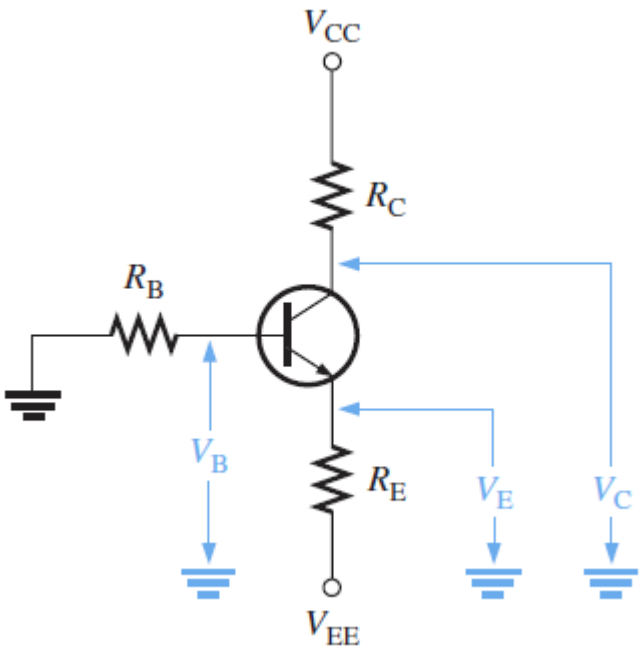


Polarizacija razdelnikom napona i otpornikom u emitoru



1. Bira se V_{CC} i I_C. Na primer, V_{CC} = 15 V i I_C = 1 mA.
2. Bira se V_E tako da bude oko 10% V_{CC}. Na primer, V_E = 1.4 V.
3. Izračunava se $R_E = V_E / I_C$ = 1.4 V / 1 mA = 1.4 kΩ.
4. Izračunava se $V_B = V_{BE} + V_E$ = 0.6 V + 1.4 V = 2 V.
5. Izračunava se struja $I_B = I_C / \beta$ = 1 mA / 100 = 10 μA.
6. Bira se struja I_2 tako da bude bar 10 puta veća od I_B. Na primer, I_2 = 10 I_B = 100 μA.
7. Izračunava se $R_2 = V_B / I_2$ = 2 V / 100 μA = 20 kΩ.
8. Izračunava se struja $I_1 = I_2 + I_B$ = 100 μA + 10 μA = 110 μA.
9. Izračunava se $R_1 = (V_{CC} – V_B) / I_1$ = (15 V – 2 V) / 110 μA = 13 V / 110 μA = 118 kΩ.
10. Izračunava se maksimalni napon na kolektoru $V_{CMAX} = V_{CC}$ = 15 V.
11. Izračunava se minimalni napon na kolektoru $V_{CMIN} = V_{CBMIN} + V_B$ = 0V + 2 V = 2 V (granica režima zasićenja).
12. Izračunava se srednja vrednost napona na kolektoru V_{CQ} = $(V_{CMAX} + V_{CMIN}) / 2$ = (15 V + 2 V) / 2 = 17 V / 2 = 8.5 V.
13. Izračunava se $R_C = (V_{CC} – V_{CQ}) / I_C$ = (15 V – 8.5 V) / 1 mA = 6.5 V / 1 mA = 6.5 kΩ.

Polarizacija sa dve baterije



$$I_B \cong I_E/\beta_{DC}$$

$$\left(\frac{I_E}{\beta_{DC}}\right)R_B + I_E R_E + V_{BE} = -V_{EE}$$

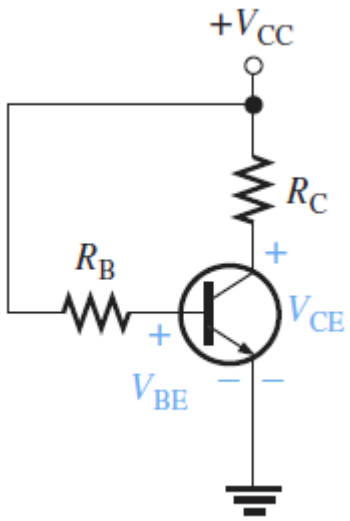
$$I_E = \frac{-V_{EE} - V_{BE}}{R_E + R_B/\beta_{DC}}$$

$$V_E = V_{EE} + I_E R_E$$

$$V_B = V_E + V_{BE}$$

$$V_C = V_{CC} - I_C R_C$$

Polarizacija baznim otpornikom



$$V_{CC} - I_B R_B - V_{BE} = 0$$

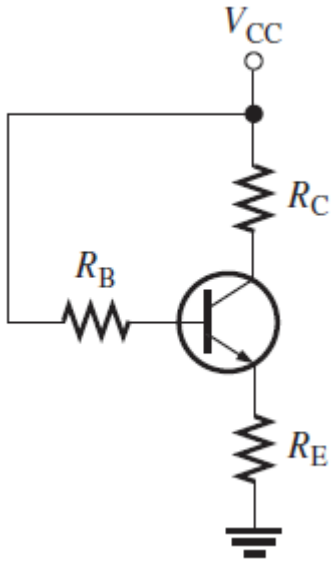
$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

$$V_{CC} - I_C R_C - V_{CE} = 0$$

$$V_{CE} = V_{CC} - I_C R_C$$

$$I_C = \beta_{DC}\left(\frac{V_{CC} - V_{BE}}{R_B}\right)$$

Polarizacija baznim i emiterskim otpornicima

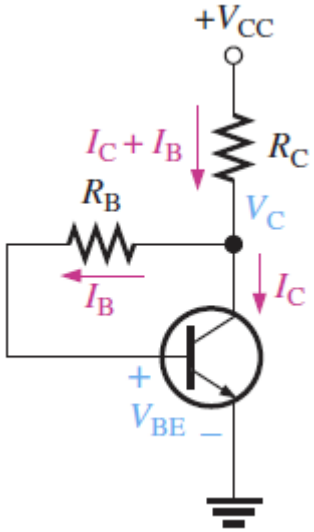


$$-V_{CC} + I_B R_B + V_{BE} + I_E R_E = 0$$

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

$$I_E = \frac{V_{CC} - V_{BE}}{R_E + R_B/\beta_{DC}}$$

Polarizacija baznim i kolektorskim otpornicima



$$I_B = \frac{V_C - V_{BE}}{R_B}$$

$$V_C \cong V_{CC} - I_C R_C$$

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

$$I_B = (V_C - V_{BE})/R_B$$

$$\frac{I_C}{\beta_{DC}} = \frac{V_{CC} - I_C R_C - V_{BE}}{R_B}$$

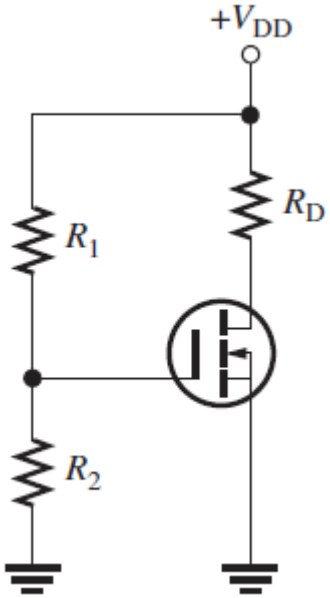
$$\frac{I_C R_B}{\beta_{DC}} + I_C R_C = V_{CC} - V_{BE}$$

$$I_C = \frac{V_{CC} - V_{BE}}{R_C + R_B/\beta_{DC}}$$

$$I_C\left(R_C + \frac{R_B}{\beta_{DC}}\right) = V_{CC} - V_{BE}$$

$$V_{CE} = V_{CC} - I_C R_C$$

Polarizacija razdelnikom napona



$$V_{GS} = \left(\frac{R_2}{R_1 + R_2}\right) V_{DD}$$

$$V_{DS} = V_{DD} - I_D R_D$$

$$I_D \approx \frac{B}{2}(V_{GS} - V_T)^2$$

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