# Wzmacniacz tranzystorowy w układzie WE (OE)

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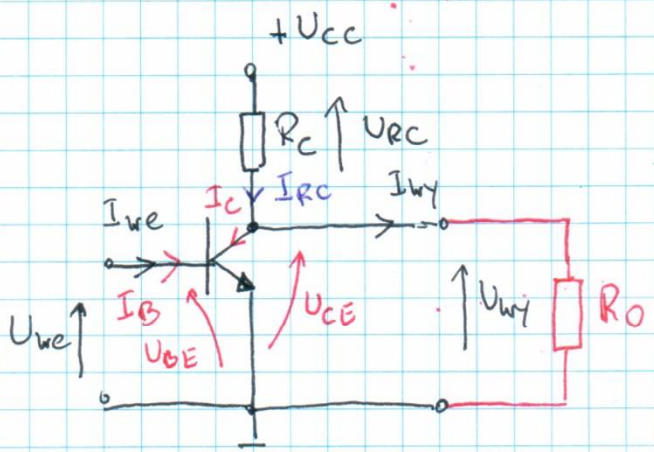



$$K_{U_0} = \frac{U_{WY}}{U_{WE}}\Big|_{I_{WY}=0} = \frac{\Delta U_{WY}}{\Delta U_{WE}}\Big|_{I_{WY}=0}$$

$$\Delta U_{WE} = \Delta U_{BE} \qquad \Delta U_{WY} = \Delta U_{CE}$$

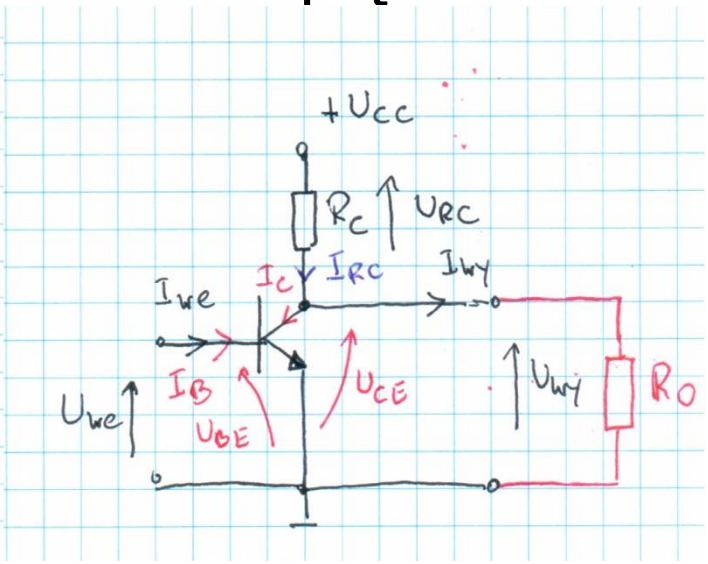
$$K_{U_0} = \frac{\Delta U_{CE}}{\Delta U_{BE}}$$

# Wyznaczenia wzoru na wzmocnienie napięciowe

$$K_{U_0} = \frac{U_{wy}}{U_{we}}\Big|_{I_{wy}=0} = \frac{\Delta U_{wy}}{\Delta U_{we}}\Big|_{I_{wy}=0}$$

$$\Delta U_{we} = \Delta U_{BE} \qquad \Delta U_{wy} = \Delta U_{CE}$$

$$K_{U_0} = \frac{\Delta U_{CE}}{\Delta U_{BE}}$$




$$U_{CC} = U_{wy} + U_{RC} = U_{wy} + I_{RC} \cdot R_C$$

dla $I_{wy} = 0$ $\quad I_{RC} = I_C$

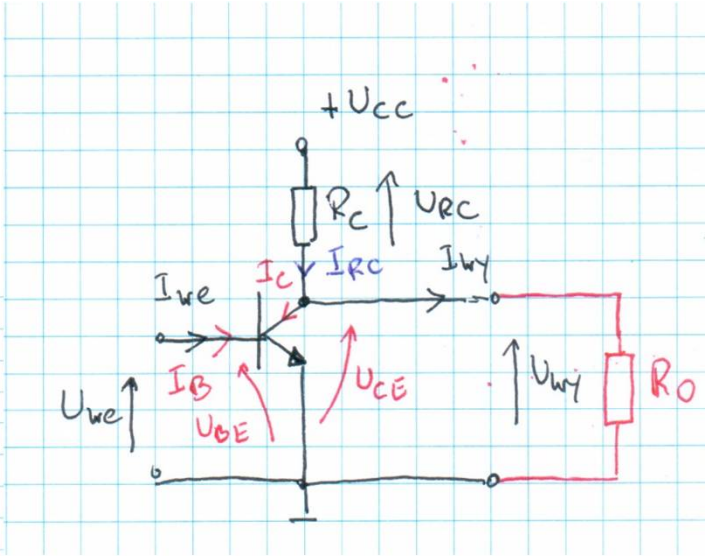
$$\Delta U_{CC} = \Delta U_{wy} + R_C \cdot \Delta I_C \qquad \Delta U_{CC} = 0$$

$$\Delta U_{wy} = -R_C \cdot \Delta I_C$$

$$I_C = -\frac{\Delta U_{wy}}{R_C} = -\frac{\Delta U_{CE}}{R_C}$$

# Wyznaczenia wzoru na wzmocnienie napięciowe

$$K_{U_0} = \frac{U_{WY}}{U_{WE}}\bigg|_{I_{WY}=0} = \frac{\Delta U_{WY}}{\Delta U_{WE}}\bigg|_{I_{WY}=0}$$




$$\Delta I_C = g_m \cdot \Delta U_{BE} + \frac{1}{r_{CE}} \cdot \Delta U_{CE}$$

$$-\frac{\Delta U_{CE}}{R_C} = g_m \cdot \Delta U_{BE} + \frac{1}{r_{CE}} \cdot \Delta U_{CE}$$

$$-\left(\frac{\Delta U_{CE}}{R_C} + \frac{\Delta U_{CE}}{r_{CE}}\right) = g_m \cdot \Delta U_{BE}$$

$$-\Delta U_{CE}\left(\frac{1}{R_C} + \frac{1}{r_{CE}}\right) = g_m \cdot \Delta U_{BE}$$

$$\Delta U_{CE} = -\frac{g_m}{\frac{1}{R_C} + \frac{1}{r_{CE}}} \cdot \Delta U_{BE} = -g_m \frac{R_C \cdot r_{CE}}{R_C + r_{CE}} \cdot \Delta U_{BE}$$

$$K_{U_0} = -\frac{g_m \cdot \frac{R_C \cdot r_{CE}}{R_C + r_{CE}} \cdot \Delta U_{BE}}{\Delta U_{BE}} = -g_m \frac{R_C \cdot r_{CE}}{R_C + r_{CE}}$$

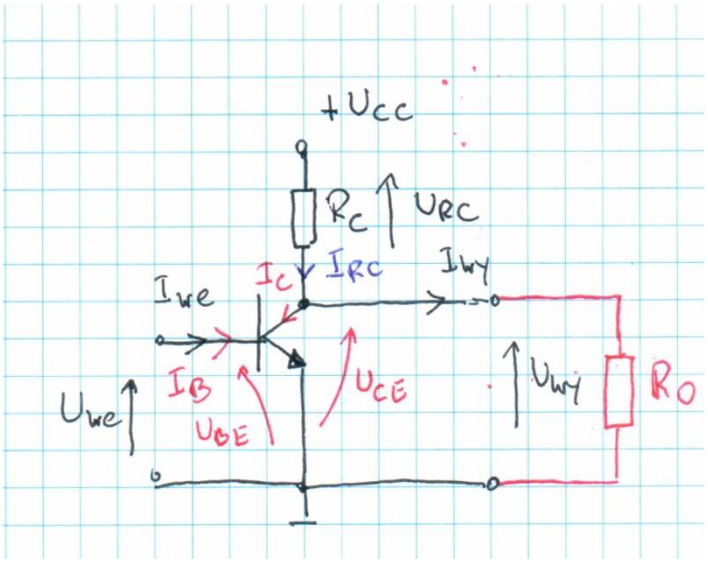
$$K_{U_0} = -g_m \cdot (R_C \| r_{CE})$$

# Wyznaczenia wzorów na rezystancje wejściową i wyjściową

$$r_{we} = \frac{\Delta U_{we}}{\Delta I_{we}} = \frac{\Delta U_{BE}}{\Delta I_B} = r_{BE}$$

$$U_{we} = U_{BE} \qquad I_{we} = I_B$$

$$\Delta I_B = \frac{1}{r_{BE}} \cdot \Delta U_{BE}$$




$$r_{we} = \frac{\Delta U_{we}}{\Delta I_{we}} = \frac{\Delta U_{BE}}{\Delta I_B} = r_{BE}$$

# Wyznaczenia wzorów na rezystancje wejściową i wyjściową

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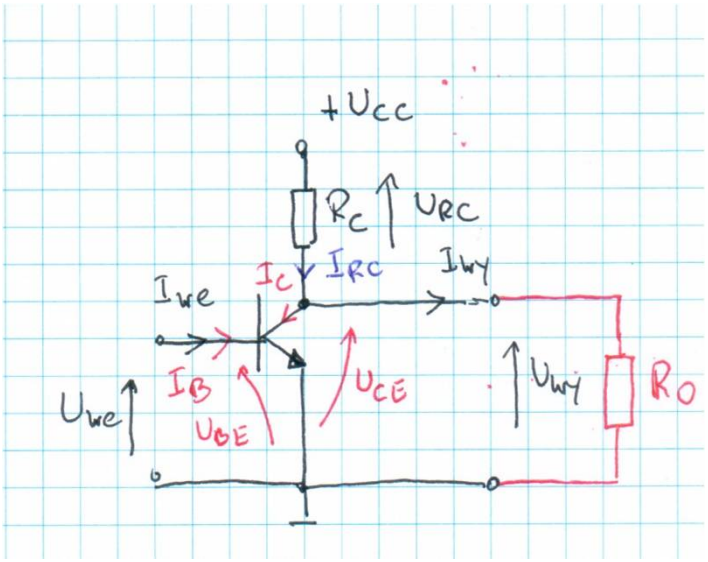
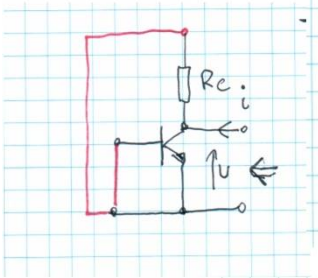
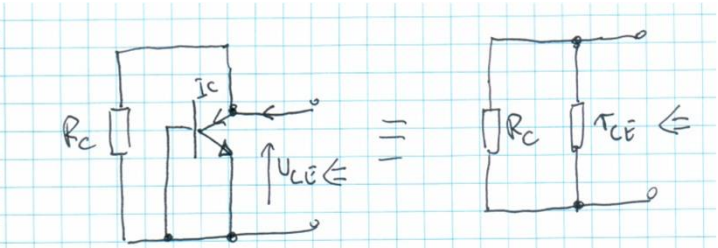



$r_{wy} = ?$

met. Thevenina
- patrzymy od zacisków wyjściowych
- zwieramy źródła napięciowe




$$r_{wy} = (R_c \parallel r_{CE}) = \frac{R_c \cdot r_{CE}}{R_c + r_{CE}}$$

$$\Delta I_C = g_m \cdot \Delta U_{BE} + \frac{1}{r_{CE}} \cdot \Delta U_{CE}$$

$\Delta U_{BE} = 0$ (zwarcie)

$$\frac{\Delta U_{CE}}{\Delta I_C} = r_{CE}$$

# Wyznaczenia wzorów na rezystancje wejściową i wyjściową

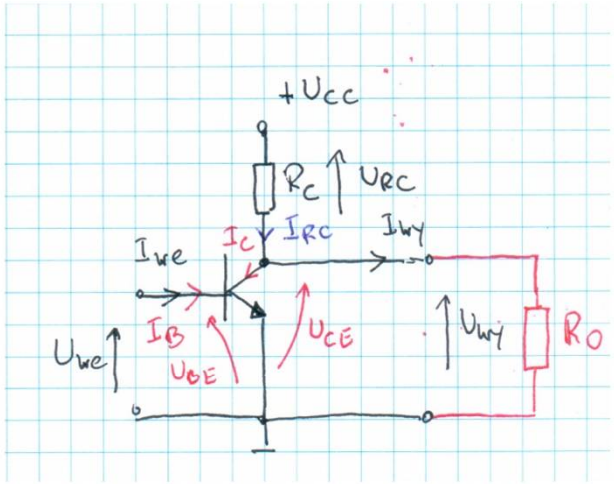
typowe wartości

$r_{CE} \approx 100\,k\Omega \qquad R_C \approx 1\,k\Omega$

$$\left(R_C \| r_{CE}\right) = \frac{R_C \cdot r_{CE}}{R_C + r_{CE}} \Big/ r_{CE} = \frac{R_C}{1 + \frac{R_C}{r_{CE}}} \approx R_C$$

$$\frac{R_C}{r_{CE}} \to 0$$

$$r_{wy} \approx R_C \qquad K_{U0} = -g_m\left(R_C \| r_{CE}\right) \approx -g_m \cdot R_C$$




$$K_{U0} = -g_m\left(R_C \| r_{CE}\right) \approx -g_m \cdot R_C$$

$$r_{we} = \frac{\Delta U_{we}}{\Delta I_{we}} = \frac{\Delta U_{BE}}{\Delta I_B} = r_{BE}$$

$$r_{wy} \approx R_C$$

$$r_{wy} = \left(R_C \| r_{CE}\right) = \frac{R_C \cdot r_{CE}}{R_C + r_{CE}}$$