KCL at node $-v_i$:

$$\frac{v^- - v_s}{R_1} + \frac{v^- - v_o}{R_2} = 0$$

$$\Leftrightarrow \frac{-v_i - v_s}{R_1} + \frac{-v_i - v_o}{R_2} = 0$$

- With $v_o = Av_i$

$$\Rightarrow \frac{-v_i - v_s}{R_1} + \frac{-v_i - Av_i}{R_2} = 0$$

$$\Leftrightarrow \frac{v_s}{R_1} = \frac{v_i}{R_1} + \frac{v_i}{R_2} + \frac{Av_i}{R_2} = -v_i\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{A}{R_2}\right)$$

- Feedback network:

$$v_f = v_s - v_i = -v_i\left(1 + \frac{R_1}{R_2} + \frac{AR_1}{R_2}\right) - v_i$$

$$= -v_i\left(2 + \frac{R_1}{R_2} + \frac{AR_1}{R_2}\right)$$

$$= -\frac{v_o}{A}\left(2 + \frac{R_1}{R_2} + \frac{AR_1}{R_2}\right)$$

$$\frac{v_o}{v_f} = -A \Big/ \left(2 + \frac{R_1}{R_2} + \frac{AR_1}{R_2}\right)$$

$$= \frac{-1}{\frac{2 + R_1/R_2}{A} + \frac{R_1}{R_2}} = \frac{1}{\beta}$$

$\rightarrow \beta = -\frac{R_1}{R_2}$, because $\frac{2 + R_1/R_2}{A} \rightarrow 0$