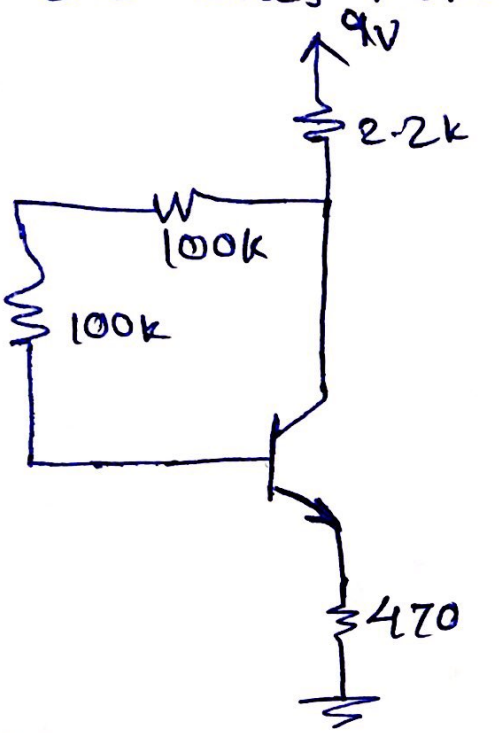
DC Bias Point (with Feed Back):



KVL: $9 - 2.2 I_C - 200 I_B$

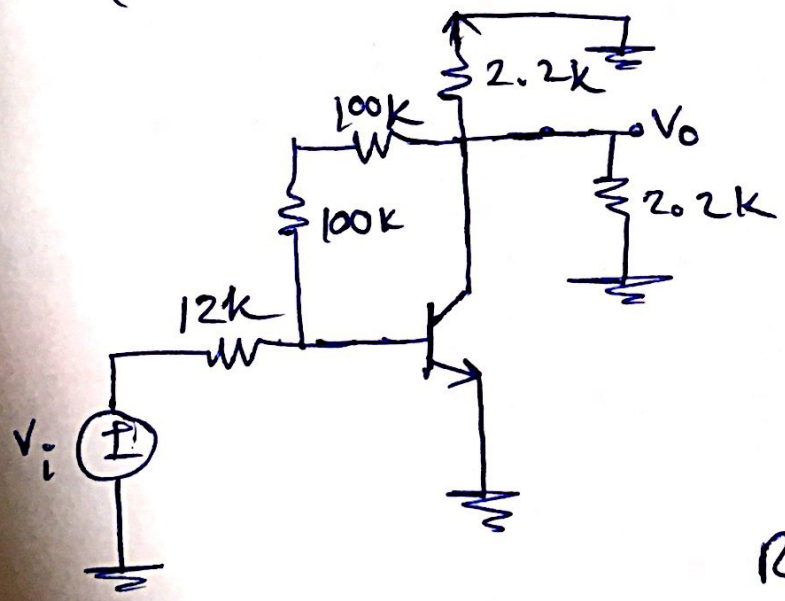
$-0.7 - 0.47 I_C = 0 \Rightarrow$

$\Rightarrow I_C = 3.1$ mA

$\Rightarrow g_m = 124$

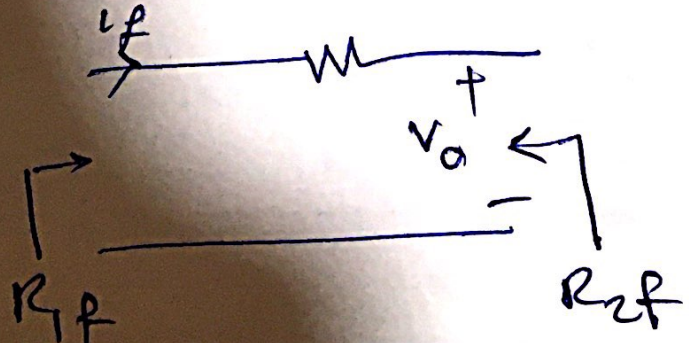
$\Rightarrow r_\pi = \frac{\beta}{g_m} = \frac{375.5}{191.9} = 3$ kΩ

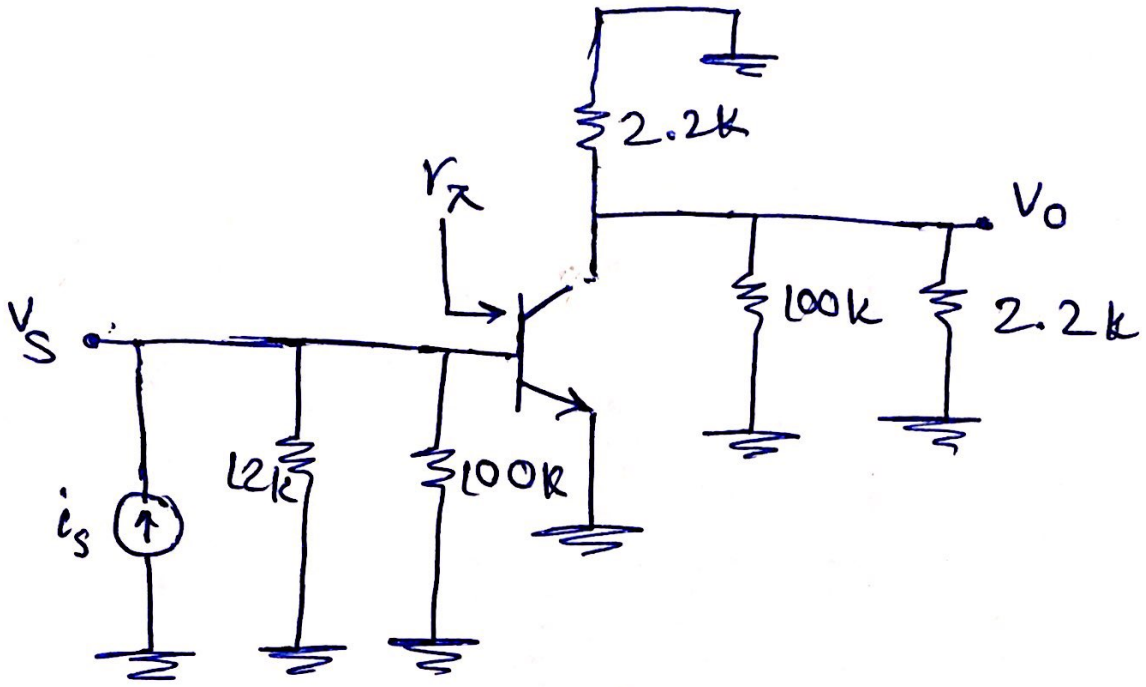
Gain (with Feed Back):



$R_{1f} = R_{2f} = 200\,k\Omega$

$\beta = \frac{i_f}{V_o} = \frac{-1}{200} \frac{1}{k\Omega}$





$$A_{OL} = \frac{V_o}{i_s} = R_{m_{OL}} = \frac{V_o}{V_s} \times \frac{V_s}{i_s} =$$

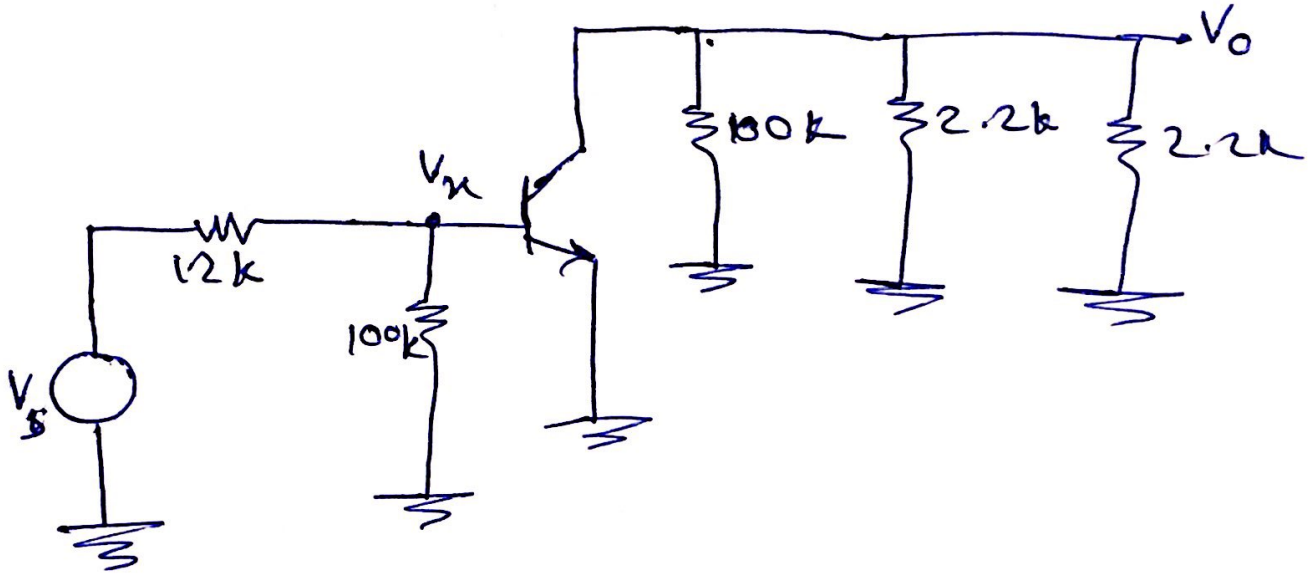
$$= -\frac{124}{\quad} \times (100k \,||\, 2.2k \,||\, 2.2k) \times (12k \,||\, 100k \,||\, 3k)$$

$$= -\frac{136.4}{\quad} \times \frac{2.34}{\quad} = -319.76\ k\Omega$$

$$A_{CL} = \frac{A_{OL}}{1 + A_{OL}\beta} = \frac{-319.76}{1 + (-319.76)(\frac{1}{100})} = -\frac{-76.17}{\quad}$$

$$\frac{V_o}{V_s} = \frac{V_o}{i_s} \times \frac{i_s}{V_s} = -\frac{-76.17}{\quad} \times \frac{1}{12} = -6.34$$

Gain (without Feedback):



$$\frac{V_o}{V_s} = \frac{V_o}{V_x} \times \frac{V_x}{V_s} = -124 \times (1.1) \times \frac{3}{3+12} =$$

$$= 27.28$$