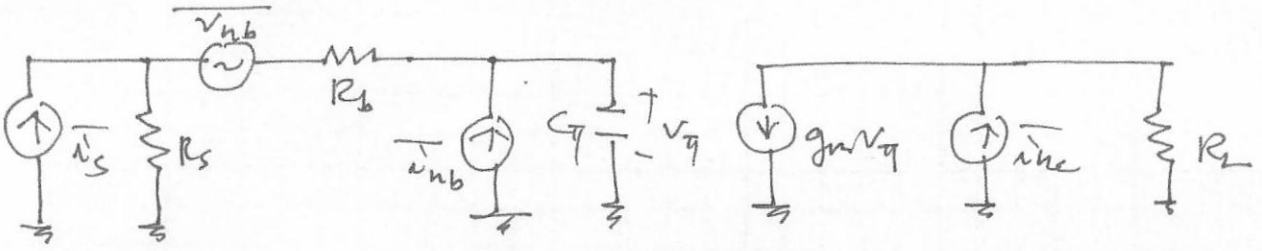
HW-2 Solution | problem-3



1) Input referred noise voltage ($= \overline{v_{in}}$)

$$\overline{v_{in}} = \overline{v_{nb}} + \overline{i_{nb}}\,(R_s+R_b) \,//\, \frac{1}{sC_\pi} + \frac{\overline{i_{nc}}}{g_m}\cdot\frac{1}{\frac{\frac{1}{sC_\pi}}{R_s+R_b+\frac{1}{sC_\pi}}}$$

$$\simeq \overline{v_{nb}} + \overline{i_{nb}}\,(R_s+R_b) + \frac{\overline{i_{nc}}}{g_m}$$

$$\left.\begin{aligned} \overline{v_{nb}} &= 4KTR_b\Delta f \\ \overline{i_{nb}} &= 2qI_B\Delta f \\ \overline{i_{nc}} &= 2qI_c\Delta f \\ g_m &= \frac{I_c}{V_T} \end{aligned}\right\} \text{apply}$$

$\Rightarrow$ Input referred noise power

$$\overline{v_{in}^2} = 4KTR_b\Delta f + 2qI_B(R_s+R_b)^2\Delta f + 2qI_c\left(\frac{V_T}{I_c}\right)^2\Delta f$$

2) Noise factor

$$F = 1 + \frac{4KTR_b\Delta f + 2qI_B(R_s+R_b)^2\Delta f + 2qI_c\left(\frac{V_T}{I_c}\right)^2\Delta f}{4KTR_s\Delta f}$$

$$= 1 + \frac{R_b}{R_s} + \frac{(R_s+R_b)^2}{R_s}\frac{1}{2}\frac{I_B}{V_T} + \frac{1}{R_s}\frac{1}{2}\frac{V_T}{I_c}$$