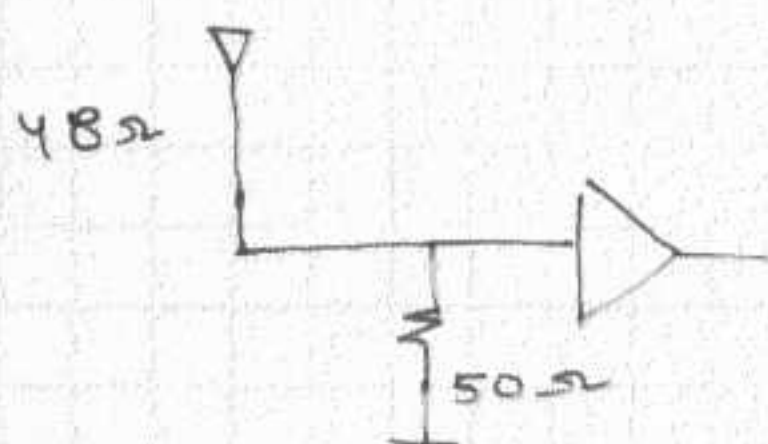
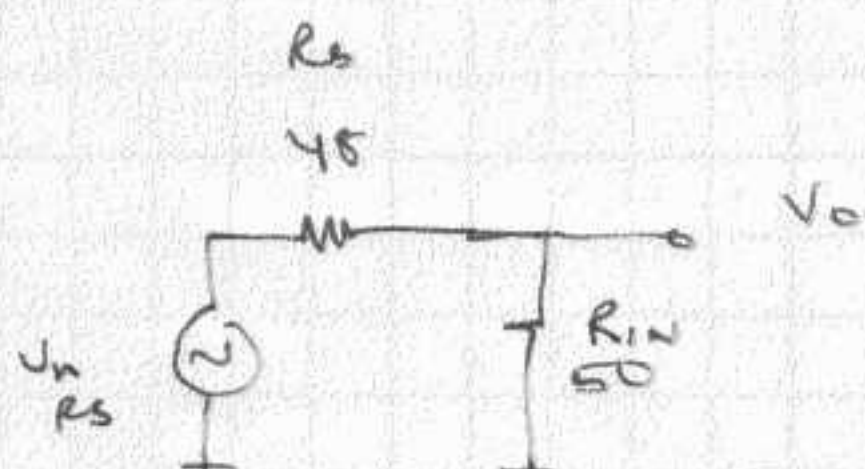




NF ?

$$NF = \frac{\text{TOTAL NOISE POWER AT OUTPUT}}{\text{NOISE POWER FROM SOURCE AT OUTPUT}}$$



$$\overline{V_o^2}_{R_s} = 4kT R_s \left(\frac{R_{in}}{R_s + R_{in}} \right)^2 \quad \text{only from source.}$$

$$\begin{aligned} \overline{V_o^2}_{\text{TOTAL}} &= 4kT R_{in} \left(\frac{R_s}{R_s + R_{in}} \right)^2 + 4kT R_s \left(\frac{R_{in}}{R_s + R_{in}} \right)^2 \\ &= \frac{4kT}{(R_s + R_{in})^2} \left[R_{in} R_s^2 + R_s R_{in}^2 \right] \end{aligned}$$

$$NF = \frac{\frac{4kT}{(R_s + R_{in})^2} \left[R_{in} R_s^2 + R_s R_{in}^2 \right]}{4kT R_s \left(\frac{R_{in}}{R_s + R_{in}} \right)^2}$$

$$= \frac{R_{in} R_s^2 + R_s R_{in}^2}{R_s R_{in}^2}$$

$$= \frac{R_s}{R_{in}} + 1$$

$$NF_{dB} = 10 \log_{10} \left[1 + \frac{R_s}{R_{in}} \right]$$