$V_{o1} = V_{o2}$

$V_o = 0$.

Case 3: $f_c < f_{in} < f_c + \Delta f$

$V_{o1} > V_{o2}$

V_{out} = Positive

Overall Noise Figure : Multistage Amplifier

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots$$

$F_1, F_2, F_3 \dots$ = Noise figures of Individual stages.
$G_1, G_2, G_3 \dots$ = Gain of each stage

Overall Noise Temperature : Multistages

$$T_{eq} = T_{eq_1} + \frac{T_{eq_2}}{G_1} + \frac{T_{eq_3}}{G_1 G_2} + \dots$$

Q. Two resistance sources R_1 and R_2 at absolute temp. T_1 and T_2 are connected in series and form white noise. Determine noise equivalent temperature

Soln.

R_1		R_2
T_1		T_2

$$\forall\ P_n = \frac{V_n^2}{4R_L} = \frac{V_{n_1}^2 + V_{n_2}^2}{4R_L}$$

$$P_n = \frac{4R_1 kT_1 \delta f + 4R_2 kT_2 \delta f}{4R_L}$$

$$P_n = \frac{4k\delta f\,(R_1T_1 + R_2T_2)}{4R_L}$$

$$P_n = kT_{eq} \cdot \delta f$$

$$T_{eq} = \frac{P_n}{k\delta f}$$

$$= \frac{4k\delta f\,(R_1T_1 + R_2T_2)/4R_L}{k\delta f}$$

$$= \frac{R_1T_1 + R_2T_2}{R_L} \qquad R_L = R_1 + R_2$$

$$= \frac{R_1T_1 + R_2T_2}{R_1 + R_2}$$

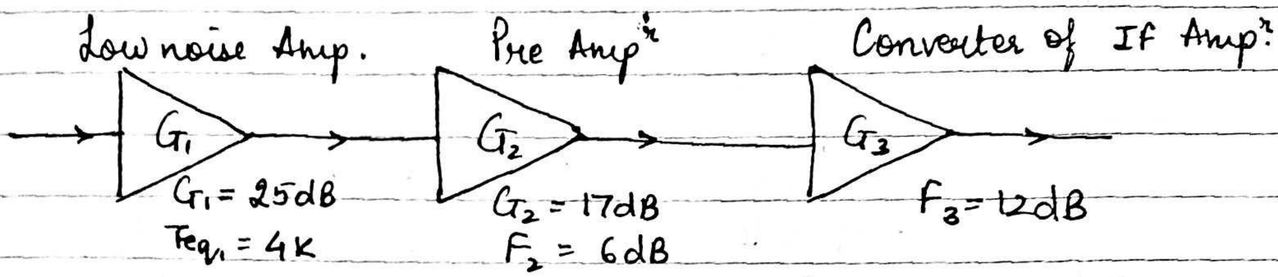
Q. Two resistance sources R_1 and R_2 at absolute temp T_1 and T_2 are connected in parallel and form white noise. Determine noise equivalent temperature.

Soln: $P_n = \frac{V_n^2}{4R_L} = \frac{V_{n_1}^2 + V_{n_2}^2}{4R_L}$

$$P_n = \frac{4R_1kT_1\delta f + 4R_2T_2k\delta f}{4R_L}$$

$$\therefore T_{eq} = \frac{(R_1T_1 + R_2T_2)(R_1 + R_2)}{R_1R_2} \qquad R_L = \frac{R_1R_2}{R_1 + R_2}$$

Q. Find out the noise equivalent temperature of the following low noise receiving system.



Assume the room temp to be 17°c.

Soln.

$$T_{eq} = T_{eq_1} + \frac{T_{eq_2}}{G_1} + \frac{T_{eq_3}}{G_1 G_2}$$

$$= 4 + \frac{T_{eq_2}}{25} + \frac{T_{eq_3}}{25 \times 17}$$

$T_{eq_2} = (F_2 - 1)T_0 =$ ~~5×~~$(17 + 290)(F_2 - 1)$

$T_{eq_3} = (F_3 - 1)T_0 =$ ~~11×~~$(17 + 290)(F_3 - 1)$

$F_2 = 10 \log_{10} F_2$

$6 = 10 \log_{10} F_2$

$\therefore F_2 = 10^{0.6} = 3.98$

$G_1 = 10^{2.5} = 316.23$

$G_2 = 10^{1.7} = 50.11$

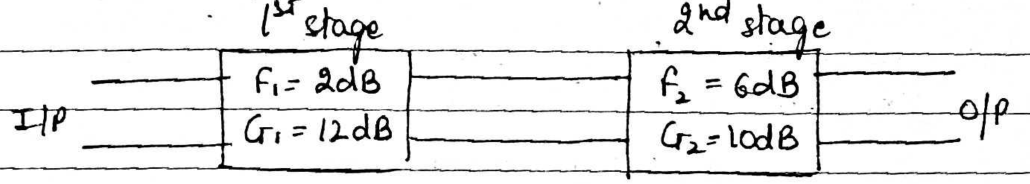
$F_3 = 10^{1.2} = 15.85$

$$T_{eq} = 4 + \frac{307 \times (3.98 - 1)}{316.23} + \frac{307 \times (15.85 - 1)}{316.23 \times 50.11}$$

$$= 4 + 2.89 + 0.29$$

$$= 7.18 \text{ K}$$

Q. A cascade two stage amplifier shown in the fig. The 1st stage has a noise figure 2dB and power gain 12dB. The 2nd stage has noise figure 6dB and power gain 10dB. Determine overall noise figure in dB.



Soln.

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \cdots$$

$$F = F_1 + \frac{F_2 - 1}{G_1}$$

$F_1 = 10^{0.2} = 1.58$

$F_2 = 10^{0.6} = 3.98$

$G_1 = 10^{1.2} = 15.8$

$G_2 = 10^{1} = 10.$

$$F = 1.58 + \frac{2.98}{15.8} = 1.76$$

$F(dB) = 10 \log_{10} 1.76$

$= 2.45 \text{ dB}$

Q. Determine overall noise figure of 3 stage cascaded amplifier. Each stage having power gain 10dB and noise figure 6dB.

Soln. $F_1 = F_2 = F_3 = 10^{0.6} = 3.98$

$G_1 = G_2 = G_3 = 10^{1} = 10.$

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}$$