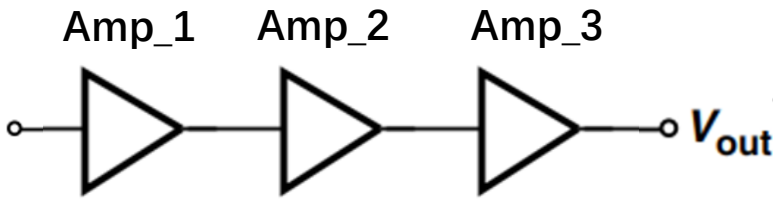
1. Suppose there are three cascaded amplifiers



Amplifier	Voltage gain(dB)	IIP_3 (V_p)	Noise Figure(dB)	A_P(dB)
1	30	2	10	20
2	20	1	20	30
3	10	500m	30	40

a) Calculate the IIP_3 of the overall chain. (Neglect second order nonlinearities.)

b) Calculate the NF of the overall chain using Friis' equation.

$$\Rightarrow \frac{1}{A_{IP_3}^2} = \frac{1}{A_{IP_{3,1}}^2} + \frac{\alpha_1^2}{A_{IP_{3,2}}^2} + \frac{\alpha_1^2\beta_1^2}{A_{IP_{3,3}}^2} = \frac{1}{(2)^2} + \frac{1000}{(1)^2} + \frac{1000 \cdot 100}{(500m)^2} \qquad \Rightarrow A_{IP_3} = 1.5792mV_p$$

$$\Rightarrow NF_{total} = 1 + (NF_1 - 1) + \frac{NF_2 - 1}{A_{P1}} + \frac{NF_3 - 1}{A_{P1} \cdot A_{P2}} = 1 + (10 - 1) + \frac{100 - 1}{100} + \frac{1000 - 1}{100 \times 1000} = 10.99999 = 10.4139dB$$

2. **A GSM receiver, which is matched to the antenna, requires a minimum SNR of 21dB and has a channel bandwidth of 1MHz as well as an NF of 12dB, determine the sensitivity of the GSM receiver.**

$$P_{RS} = kT = -174dBm/Hz$$

$$P_{sen} = -174dBm/Hz + NF + 10\log B + SNR_{\min} = -81dBm$$

3. **Why do we need upconverter in transmitter and downconverter in receiver?**

1. Avoid interference 2. High frequencies correspond to small antenna area 3. medium frequency is more suitable for signal processing and makes it easier to make good filters

4. **Say a desired signal of f_0=2.4GHz is received by a nonlinear amplifier, accompanied by two interferers at f_1=2.6GHz and f_2=2.8GHz. What will happen at the output of the amplifier?**

intermodulation product falling at $f_0 = 2f_1 - f_2$ will cause interference to the desired signal