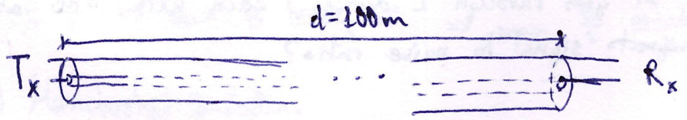
2.2.2.

In a coaxial cable, attenuation followed this rule: $Att = 2f^2 \frac{dB}{kHz^2 \cdot km}$ $\left[\frac{dB}{km}\right]$. A traffic generator sends BPSK signals at 10 mW. Compute

a) The received power on the other end of a 100 m cable if the sine wave has $f = 10$ kHz.



$$S_R = S_T \cdot 10^{-\frac{d \cdot Att}{10}} = S_T \cdot 10^{-\frac{d}{10} 2f \frac{dB}{kHz^2 \cdot km}} = 10\,mW \cdot 10^{-\frac{0.1km}{10dB} \cdot 2 \cdot (10kHz)^2 \frac{dB}{kHz^2 \cdot km}} = 10\,mW \cdot 10^{-\frac{2}{10}} = \boxed{6.31\ mW}$$

b) The minimum frequency of the sine wave to get farther than (i) 100 m and (ii) 2.5 km. Assume receiver sensitivity −60 dBm

$$-d \cdot Att_d = 10 \log_{10} \frac{S_R}{S_T} \Rightarrow 2f^2 \frac{dB}{kHz^2 \cdot km} = -\frac{10}{d} \log_{10} \frac{S_R}{S_T} \Rightarrow f = \sqrt{-\frac{5}{d} \frac{kHz^2\,km}{dB} \log_{10} \frac{S_R}{S_T}}$$

$$S_R = 60\,dBm = 1mW \cdot 10^{\frac{-60}{10}} = 10^{-6}\ mW$$

$$f = \sqrt{-\frac{5}{d}\ kHz^2\,km \cdot \log_{10} \frac{10^{-6}}{10}} = \sqrt{\frac{35}{d}\ kHz^2\,km} = \sqrt{\frac{35\,km}{d}}\ kHz$$

i) $f(d=100m) = \sqrt{\frac{35}{0.1}}\ kHz = \boxed{18.71\ kHz}$

ii) $f(d=2.5km) = \sqrt{\frac{35}{2.5}}\ kHz = \boxed{3.74\ kHz}$

2.2.3.

Calculate max data rate in a 3kHz channel with SNR= 20 dB using a binary signal

$$C = B \log_2 \left(1 + \frac{S}{N}\right) = 3\,kHz \cdot \log_2 \left(1 + 10^{\frac{20}{10}}\right) = 19.97\ kbps$$

Binary signal $\Rightarrow L = 2 \rightarrow C = 2B \log_2 L = 2 \cdot 3\,kHz \log_2 2 = \boxed{6\,kbps}$