Q1 [50 pts] – Transmission Rate

Scenario I: In a SISO system, the bandwidth and SNR are given as $W_I = 1$ MHz and $\text{SNR}_I = 30$ dB, respectively. Note that $\text{SNR} = \frac{P_S}{P_N} = \frac{P_S}{(W\text{N}_0)}$.

Scenario II: In order to increase the transmission rate in this SISO system, bandwidth is increased by 100 times; that is, $W_{II} = 100$ MHz. The transmit power remains unchanged.

Determine, how many times the rate can be increased by increasing the bandwidth by 100 times; i.e., find $\frac{R_{\text{max,II}}}{R_{\text{max,I}}}$. ($R_{\text{max}} = \text{Maximum transmission rate}$.)

Q2 [50 pts] – Square Root Raised Cosine Filters

It is discussed in the lectures that the power spectral density of the transmitted signal can be written as $S_X(f) = \frac{1}{T} |H_{TX}(f)|^2$, where $h_{TX}(t)$ is the transmitter filter and $T$ is the bit duration.

Assume that $h_{TX}(t)$ is chosen as a square root raised cosine filter with 50% excess bandwidth. That is, $H_{TX}(f) = |P(f)|^{\alpha/2}$, with $\alpha = 0.5$. Sketch $S_X(f)$. Compute the total transmit power.