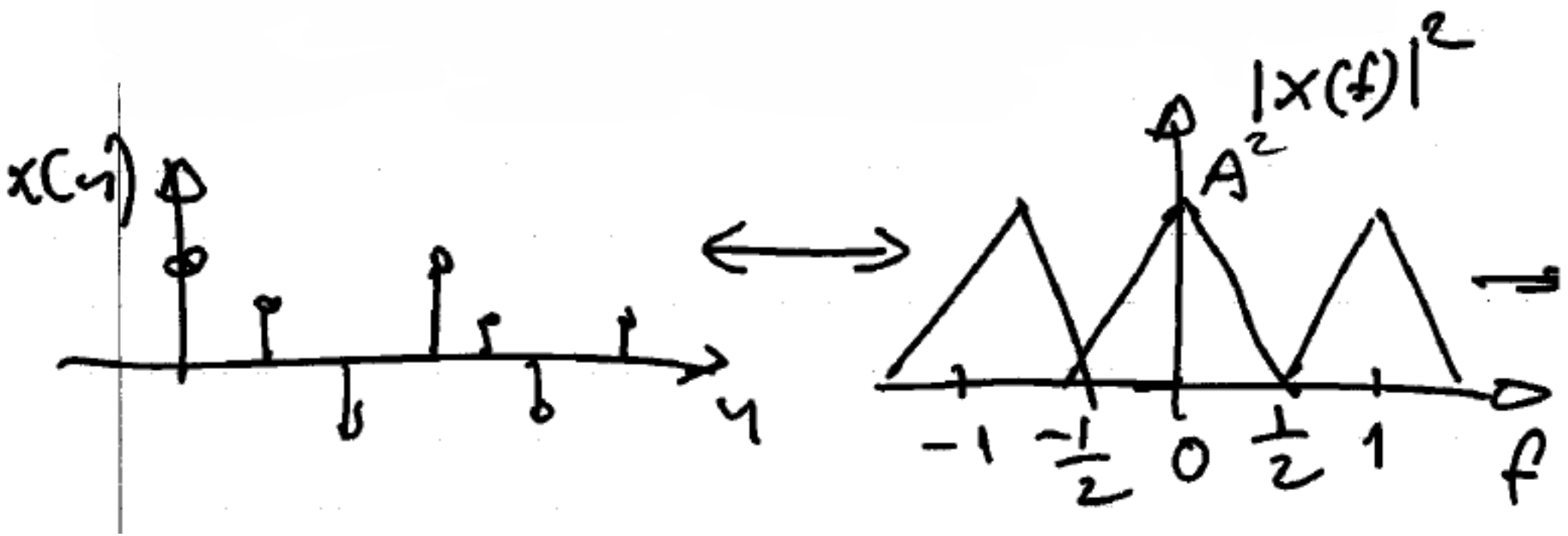
ECE462 – Lecture 30

Oversampling and Quantization

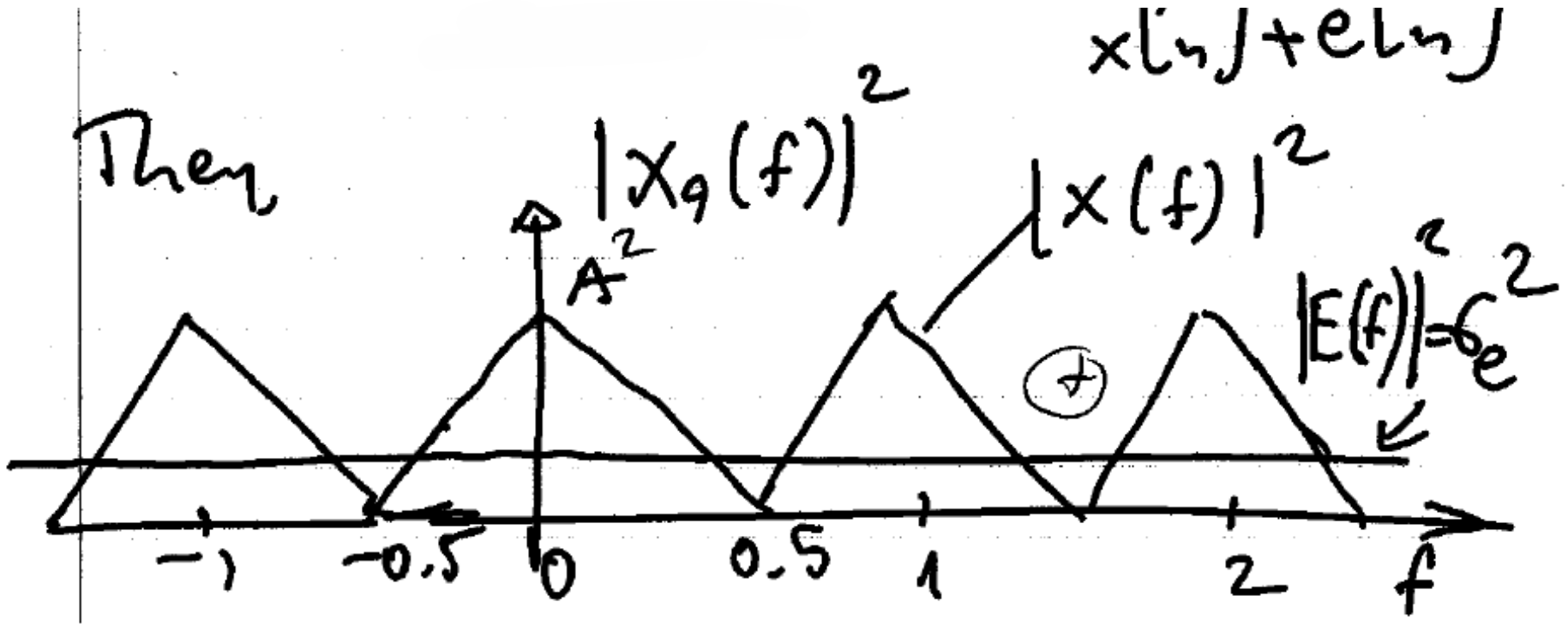
- Let x[n[be a discrete signal with DTFT X(f) . Then let



Oversampling and Quantization

- x[n] is quantized using B bits -> $x_q[n] = x[n] + e[n]$

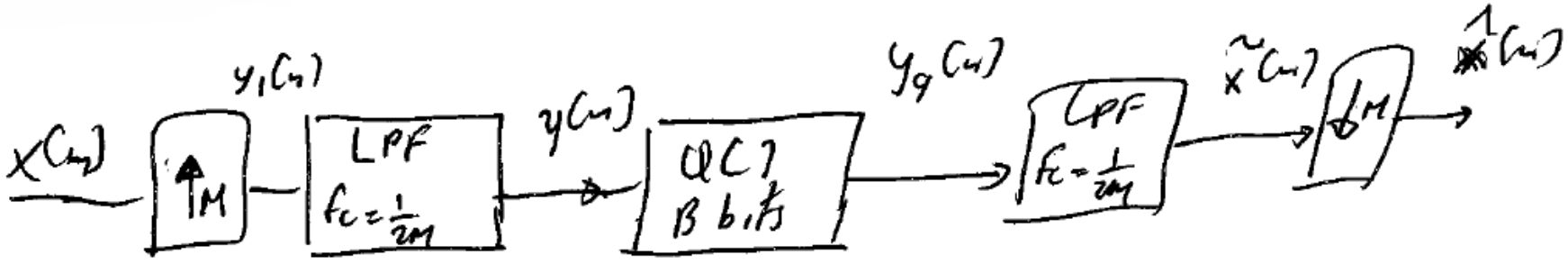
- Then,



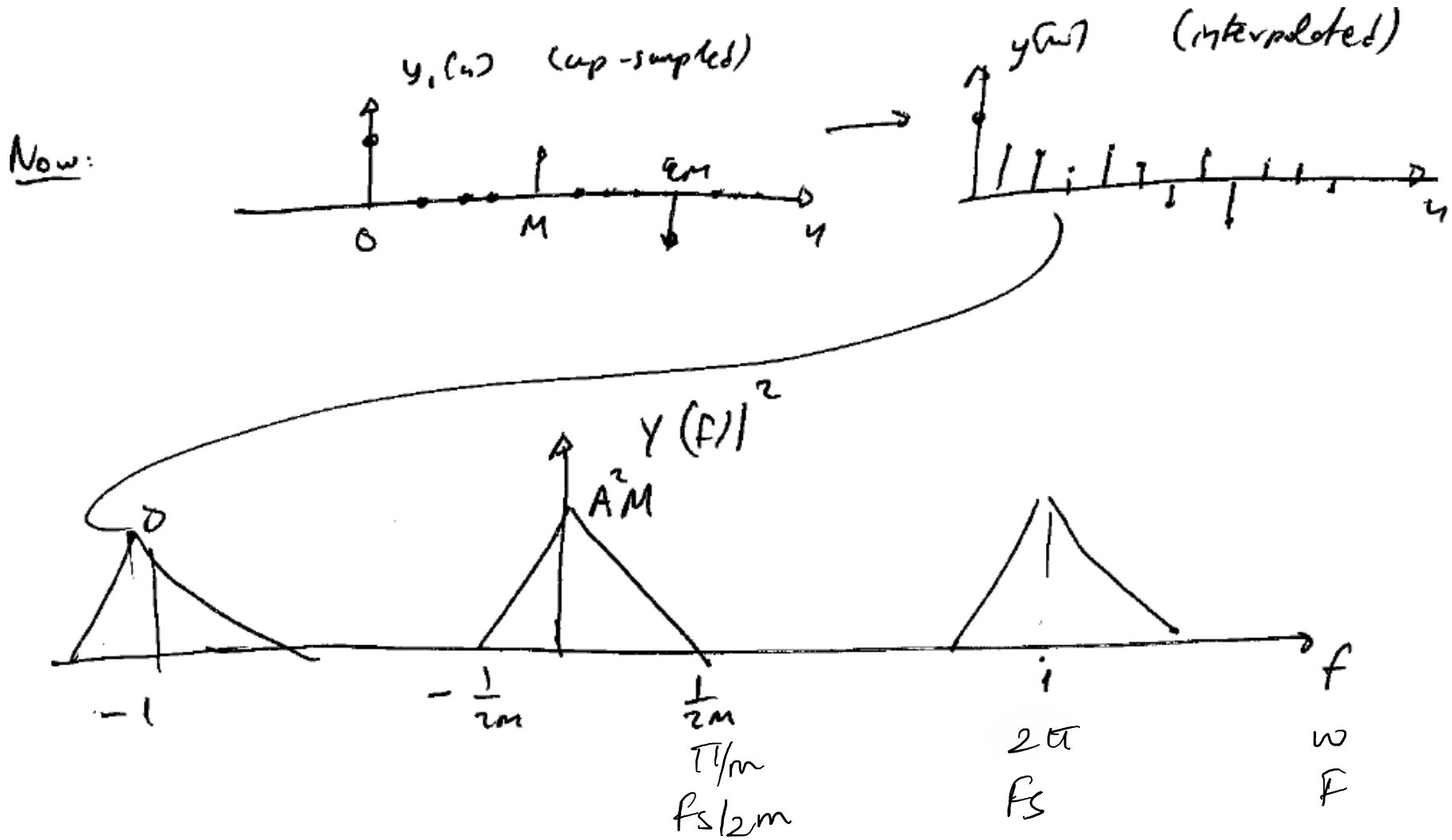
Oversampling and Quantization

Then, SQNR = $10 \log_{10} \frac{1}{2} \frac{A^2}{\sigma_e^2}$

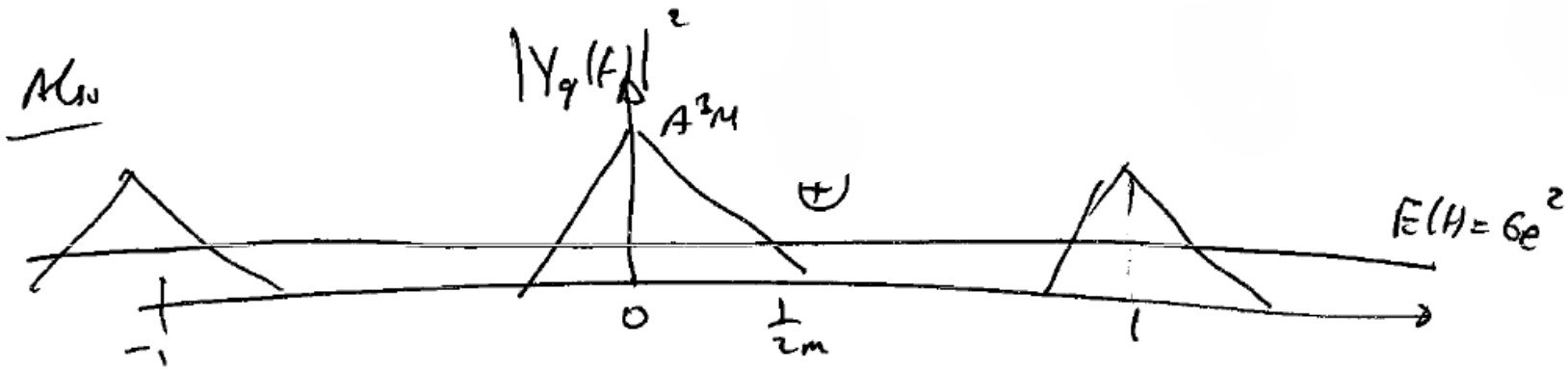
Now consider interpolating x[n[by a factor of M, then quantize to B bits and then decimate by a factor of M. That is



Oversampling and Quantization



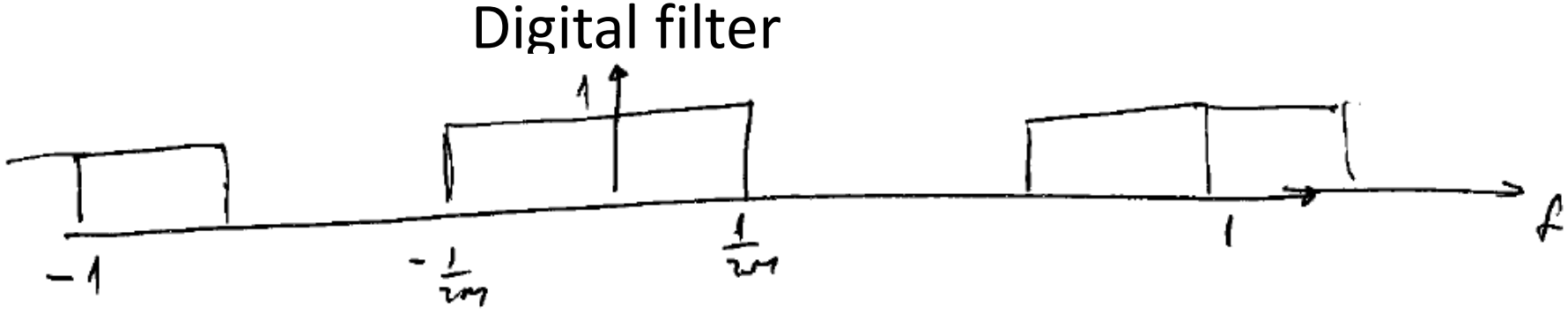
Oversampling and Quantization

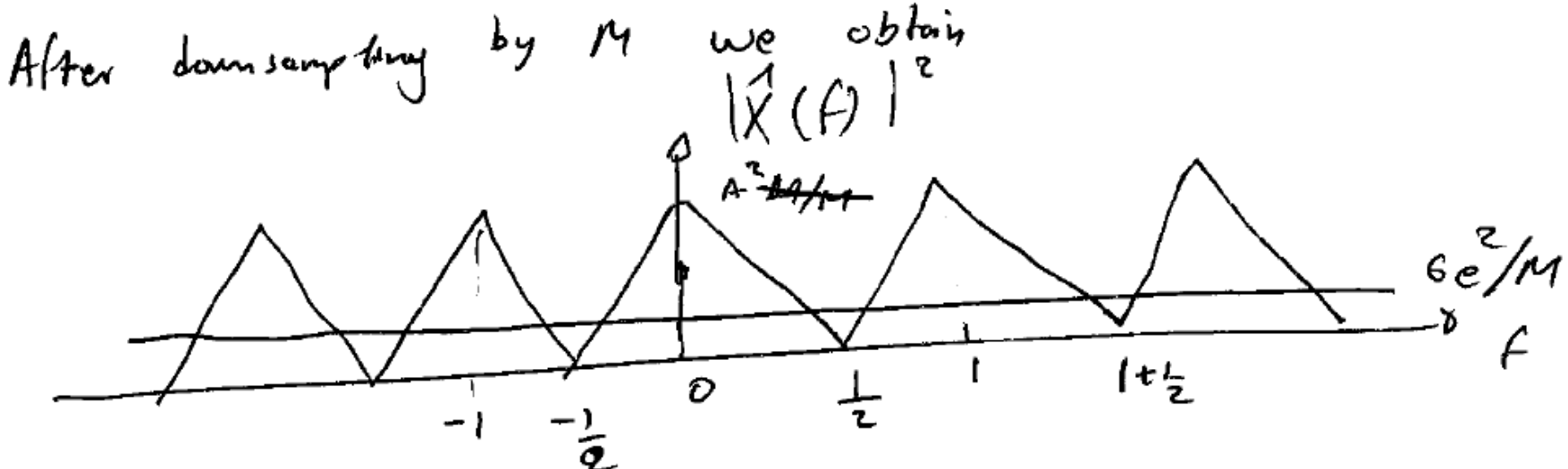


- Notice that σ_e^2 is the same whether you quantize x[n] or y[n] since the number of bits/sample is the same in both cases.
- Observe that the desired signal spectrum is between $-\frac{1}{2M} \leq f \leq \frac{1}{2M}$

Oversampling and Quantization

- Thus we can use a digital low pass filter to extract the desired signal





Oversampling and Quantization

- Note that x[n] and $\hat{x}[n]$ have the same rate
- So in this case
- $\text{SQNR}_1 = 10\log_{10}\frac{\frac{1}{2}A^2}{\frac{\sigma_e^2}{M}} = 10\log_{10}\frac{A^2M}{2\sigma_e^2}$ dB
- The gain in dB is
- $\text{SQNR}_1 = \text{SQNR} = 10\log_{10}\frac{A^2M}{2\sigma_e^2} - 10\log_{10}\frac{A^2}{2\sigma_e^2} = 10\log_{10} M \ \ dB$
- In terms of bits $10\log_{10} M = 6.01\ B$ that is for B=1 and M=4