Communication Systems
Lab – 2 Report

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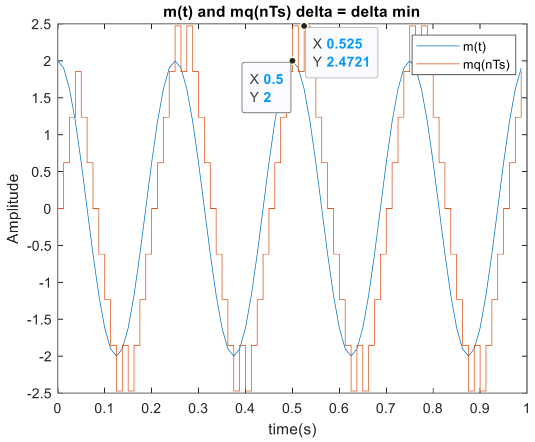
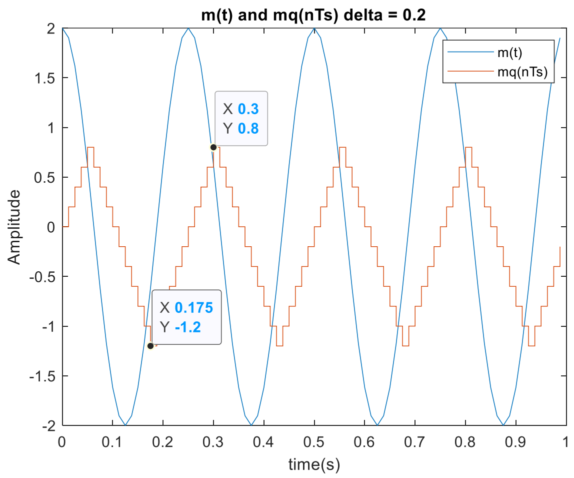
Figure 1



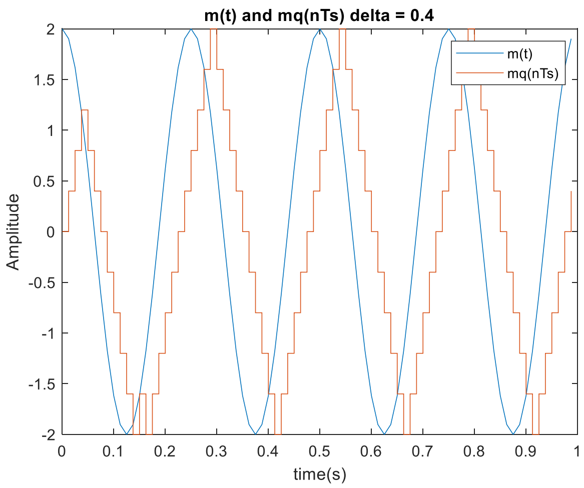
We see that our modulated signal with calculated delta has speed of exactly the message signal. Therefore, the stairs can catch the original signal and we do not observe slope overload distortion.

Figure 2



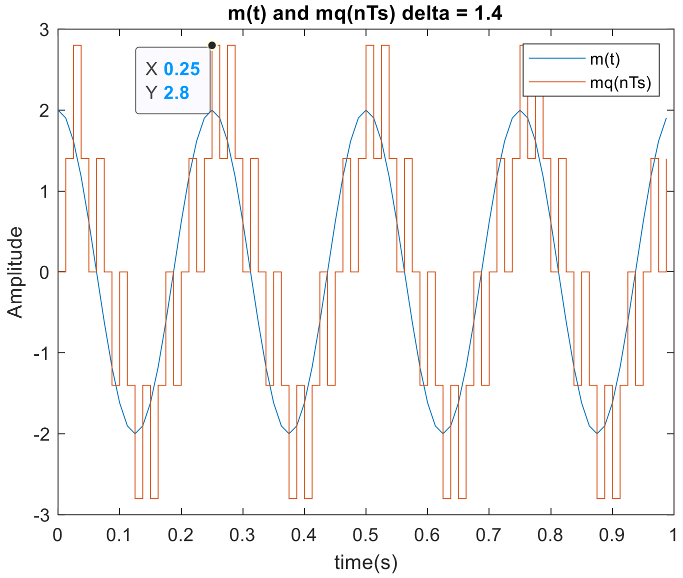
Since our Delta/Ts, slope of the stairs, is lower than m(t), it falls behind it. Hence, we come across with slope overload condition.

Figure 3



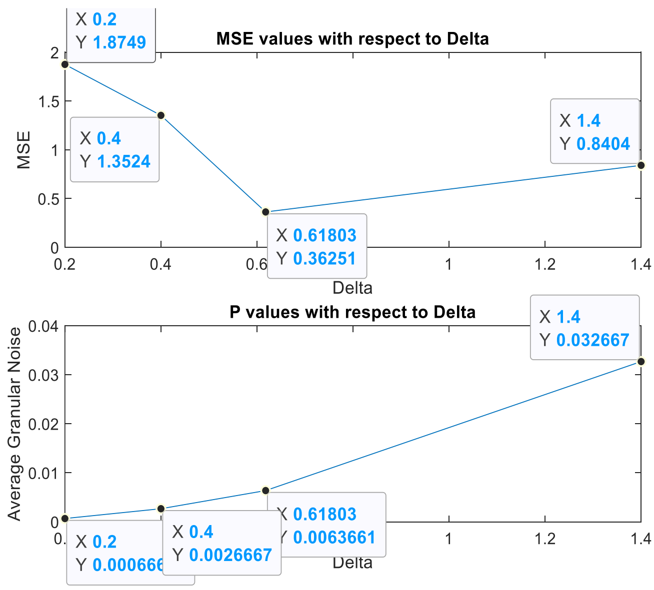
Again, our stairs' slope speed is less than m(t), therefore it struggles to modulate the signal without error and always follows the signal a bit behind. However, it is much better than figure 1.

Figure 4



Since, slope of mq(nTs) is higher than optimum level, we encounter with granular noise a lot. This is because, while it is trying to match with m(t), it often overshoots and comes back.

Figure 5



We observe that MSE is getting higher when delta is higher or lower than 0.618 because when it is greater, the modulation creates granular noise and when it is lesser, it emerges slope overload distortion(noise).

For the second plot, we expect to see higher granular noise when delta is bigger because in that case, when mq(nTs) goes over m(t), it overshoots in greater amount. Furthermore, it is seen in the formula that P directly proportional to square of delta just like in the figure.

Questions

Report-Q1

If the condition of $\frac{\Delta}{T_s} \geq max|\frac{dm(t)}{dt}|$ satisfies, we unlikely to see slope overload distortion because when the quantization is slower than m(t), it falls behind and creates slope overload distortion.

Report-Q2

Indeed, it is impossible to emerge no error for delta modulation. For delta values which is lower than $\boldsymbol{max\left|\frac{dm(t)}{dt}\right| * Ts}$, we expect to see slope overload distortion. Also, for all values we see granular noise, but it gets higher when the delta is greater.

Report-Q3

We see that they are inversely proportional. When granular noise increase, slope overload distortion decreases and the opposite. We see the least MSE at delta minimum because while the delta is getting bigger or smaller than delta minimum, one of the noises increases. Therefore, we need to find a sweet spot for the lowest MSE of delta which is $\boldsymbol{max\left|\frac{dm(t)}{dt}\right| * Ts}$.

Report-Q4

We cannot improve the performance with constant delta value. On the other hand, with adaptive delta modulation according to the input signal, we can decline both granular noise and slope overload distortion.

Report-Q5

Sample values are represented by one bit. If the bit is 1, demodulator adds one delta to mq*(*nTs - Ts*)* and if it is 0, demodulator subtracts one delta from mq*(*nTs - Ts*).* Furthermore, while encoding the signal, if m(nTs) is greater than m(nTs-Ts), it encodes as 1 and in the opposite case, it encodes as 0.