REPORT

Zajęcia: Analog and digital electronic circuits
Teacher: prof. dr hab. Vasyl Martsenyuk

Lab 5
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Topic: "Quantization"
Variant 2

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stacjonarne,
1 semestr,
Gr.2

1. Problem statement: The objective is to investigate Uniform Saturated Midtread Characteristic Curve of quantization

2. Input data:

$\Omega_c = t^3$

3. Commands used (or GUI):

a) source code

Quantizer definition

```
def my_quant(x, Q):
    tmp = Q//2  # integer div
    quant_steps = (np.arange(Q) - tmp) / tmp  # we don't use this

    # forward quantization, round() and inverse quantization
    xq = np.round(x*tmp) / tmp
    # always saturate to -1
    xq[xq < -1.] = -1.
    # saturate to ((Q-1) - (Q\2)) / (Q\2), note that \ is integer div
    tmp2 = ((Q-1) - tmp) / tmp  # for odd N this always yields 1
    xq[xq > tmp2] = tmp2
    return xq
```

Quantizer check function definition

```
def check_my_quant(Q):
    N = 5
    r = np.arange(N)
    x = np.power(r, 3)
    xq = my_quant(x, Q)
    e = xq - x

    plt.xlim(-5, 5)
    plt.ylim(-10, 10)
```

```
    plt.plot(r, x, color='C2', lw=3, label=r'$x[k]$')
    plt.plot(r, xq, color='C3', label=r'$x_q[k]$')
    plt.plot(r, e, color='C0', label=r'$e[k] = x_q[k] - x[k]$')
    plt.xlabel('input amplitude')
    plt.ylabel('output amplitude')
    if np.mod(Q, 2) == 0:
        s = ' saturated '
    else:
        s = ' '
    plt.title(
        'uniform'+s+'midtread quantization with Q=%d steps, $\Delta Q$=%4.3e'
% (Q, 1/(Q//2)))
    plt.axis('equal')
    plt.legend(loc='upper left')
    plt.grid(True)
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    N = 5
    r = np.arange(N)
    x = np.power(r, 3)
    xq = my_quant(x, Q)
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```

```
    plt.legend(loc='upper left')
    plt.grid(True)
```

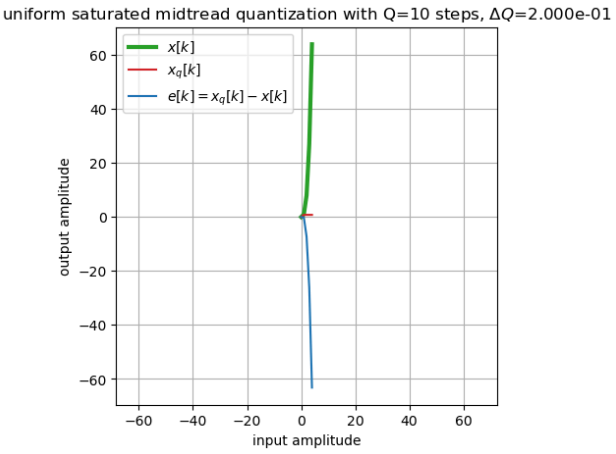
Plotting results for Q = 9 and Q = 10

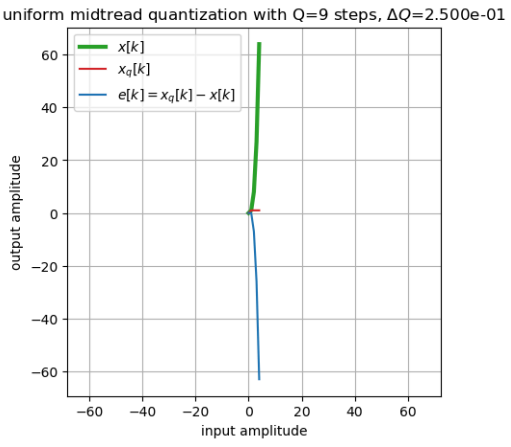
```
Q = 9  # number of quantization steps
deltaQ = 1 / (Q//2)  # general rule
deltaQ = 2 / (Q-1)  # for odd Q only
plt.figure(figsize=(5, 5))
check_my_quant(Q)

Q = 10  # number of quantization steps
deltaQ = 1 / (Q//2)  # general rule
deltaQ = 2 / (Q-1)  # for odd Q only
plt.figure(figsize=(5, 5))
check_my_quant(Q)
```

https://github.com/wm64167/AADEC

4. Outcomes:





5. Conclusions:

In conclusion, this lab investigated the Uniform Saturated Midtread Characteristic Curve of quantization. A quantizer was constructed for a given signal and the error signal along with its auto-correlation function were plotted.

The midtread concept and saturation (for even Q) were explored by comparing quantizer curves for Q=9 and Q=10. This allows for understanding the impact of the number of quantization levels on the performance of the quantizer.