Laborator 6

1) $x(t) = A \sin(\omega t + \varphi)$

$$\varphi_x(\tau) = \frac{1}{T_0} \int_0^{T_0} A \sin(\omega t + \varphi) \, A \sin(\omega_0 (t-\tau) + \varphi)$$

$$= \frac{1}{T_0} \int_0^{T_0} A \sin(\omega_0 (t-\tau) + \varphi) \, A \sin(\omega_0 t + \varphi)$$

$$= \frac{A^2}{T_0} \int_0^{T_0} \sin(\omega_0 (t+\tau) \sin(\omega_0 t + \varphi)$$

$$= \frac{A^2}{2T_0} \int_0^{T_0} \left(\cos(-\omega_0 \tau) - \cos(2\omega_0 t + 2\varphi - \omega_0 \tau) \right)$$

$$= \frac{A^2}{2T_0} \int_0^{T_0} \left(\cos(\omega_0 \tau) - \cos(2\omega_0 t + 2\varphi - \omega_0 \tau) \right)$$

$$= \frac{A^2}{2T_0} \cos(\omega_0 \tau) t \Big|_0^{T_0} - \frac{A^2}{2T_0} \cdot \frac{1}{2\omega_0} \sin(2\omega_0 t + 2\varphi - \omega_0 \tau) \Big|_0^{T_0}$$

$$= \frac{A^2}{2} \cos(\omega_0 \tau) - \frac{A^2}{8\pi} \left(\sin(4\pi) \cos(2\varphi - \omega_0 \tau) + \right.$$

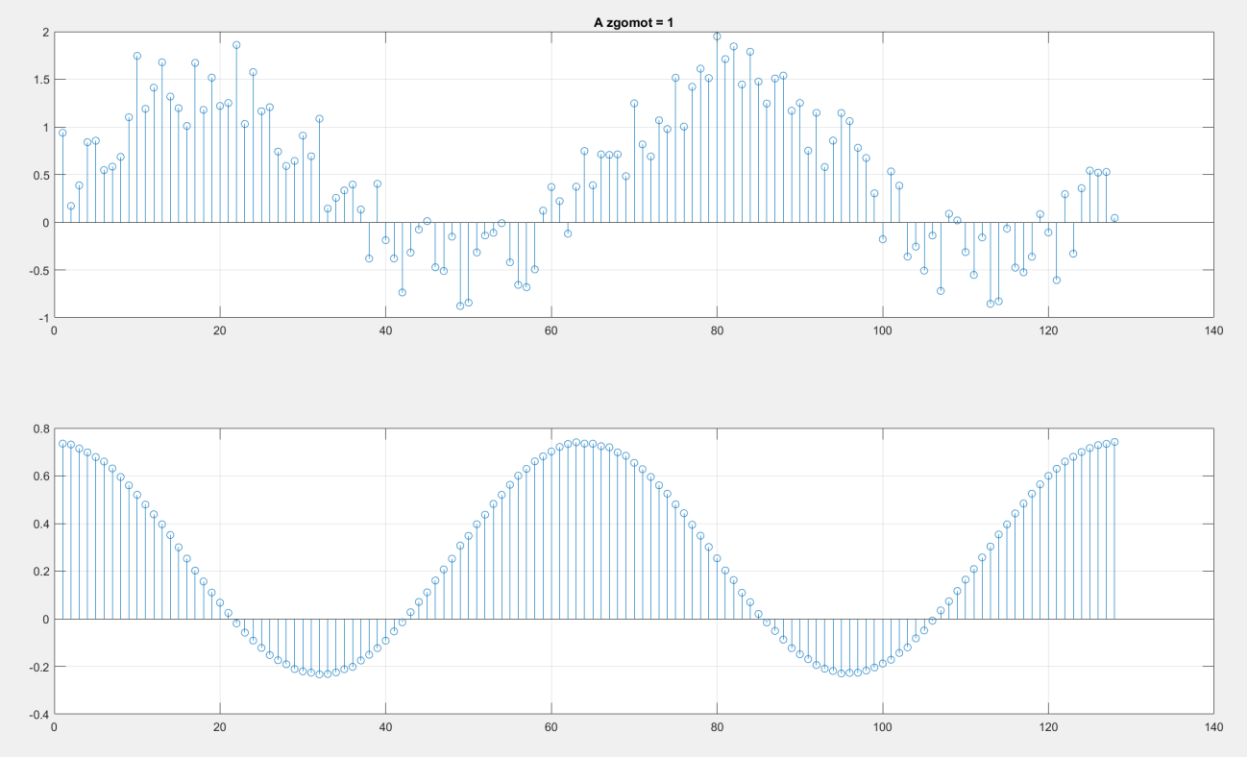
$$\left. + \cos(4\pi) \sin(2\varphi - \omega_0 \tau) - \sin(2\varphi - \omega_0 \tau) \right)$$

$$= \frac{A^2}{2} \cos(\omega_0 \tau) - \frac{A^2}{8\pi} \left(0 \cdot \sin(2\varphi - \omega_0 \tau) + \sin(2\varphi - \omega_0 \tau) \right)$$

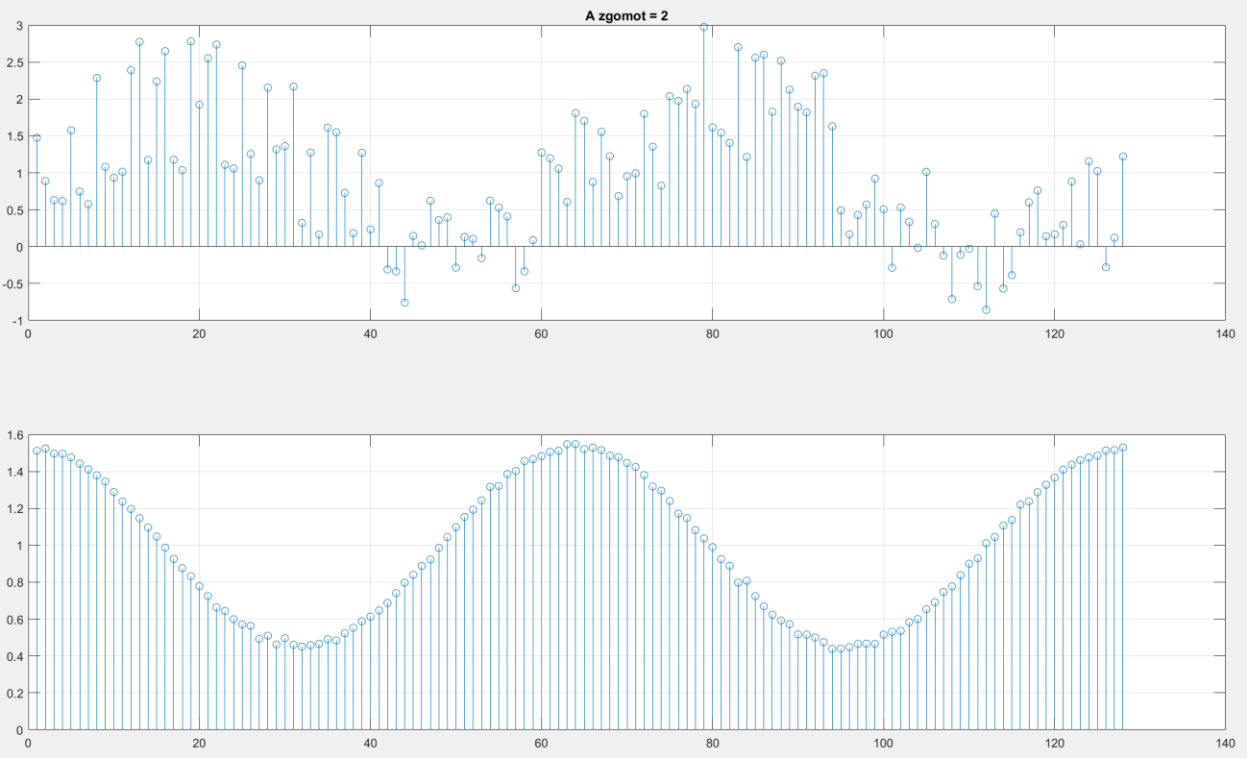
$$\Rightarrow \varphi_x(\tau) = \frac{A^2}{2} \cos(\omega_0 \tau)$$

```
%% 2
function phix = aurocorr_2(x,N,M)
% a

    if(length(x) < M+N)
        phix = [];
        return
    end

    phix = zeros(1,N);
    for n = 1:N
        for k = 1+n:M + n
            phix(n) = phix(n) + x(k) * x(k-n);
        end
    end
    phix = phix / M;

end

clc
clear all
close all

%%
% b
N = 128;
M = 1000;
n = 0:N+M-1;
xp = 1*sin(2*pi*n/64);

% c
A = 1;
x = xp + A * rand(1,length(n));

% d
phixx = autocorr_2(x,N,M);
```

```
% e
figure(1)
A = 1;
x = xp + A * rand(1,length(n));
phixx = autocorr_2(x,N,M);
subplot(2,1,1); title("A zgomot = 1");
stem(x(1:N)); grid;
subplot(2,1,2);
stem(phixx); grid;
```



```
figure(2)
A = 2;
x = xp + A * rand(1,length(n));
phixx = autocorr_2(x,N,M);
subplot(2,1,1); title("A zgomot = 2");
stem(x(1:N)); grid;
subplot(2,1,2);
stem(phixx); grid;
```



```
figure(3)
A = 3;
x = xp + A * rand(1,length(n));
phixx = autocorr_2(x,N,M);
subplot(2,1,1); title("A zgomot = 3");
stem(x(1:N)); grid;
subplot(2,1,2);
stem(phixx); grid;
```