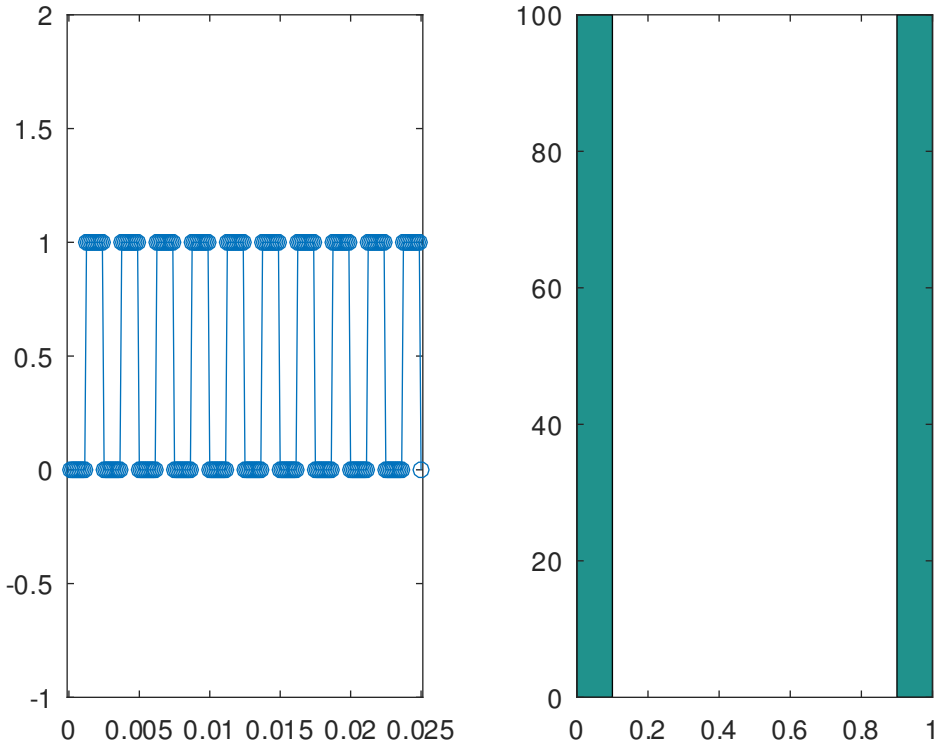
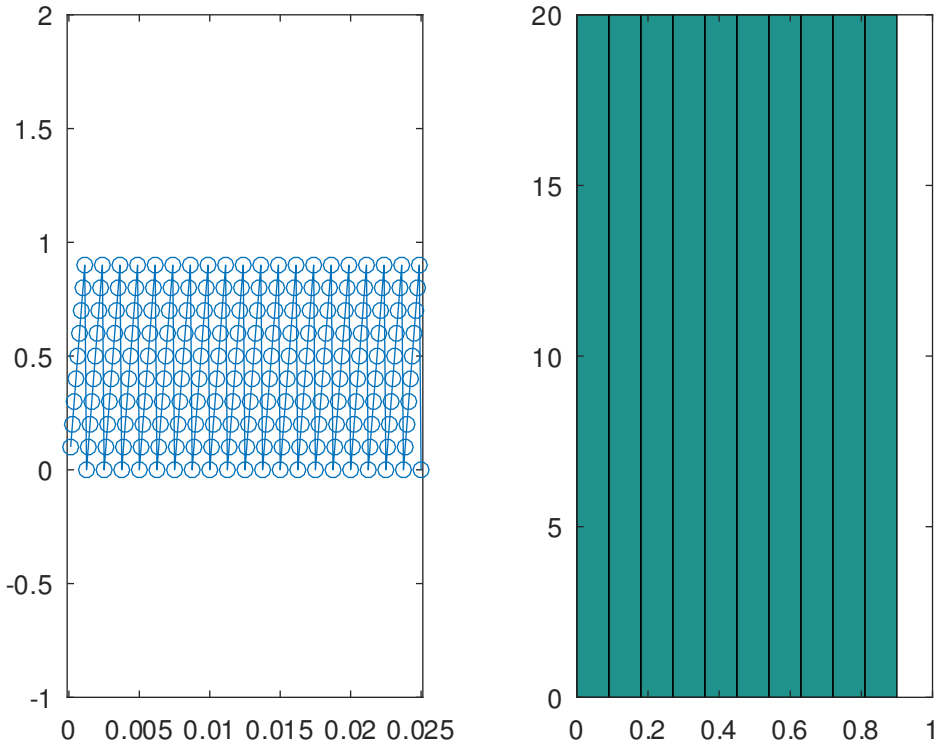
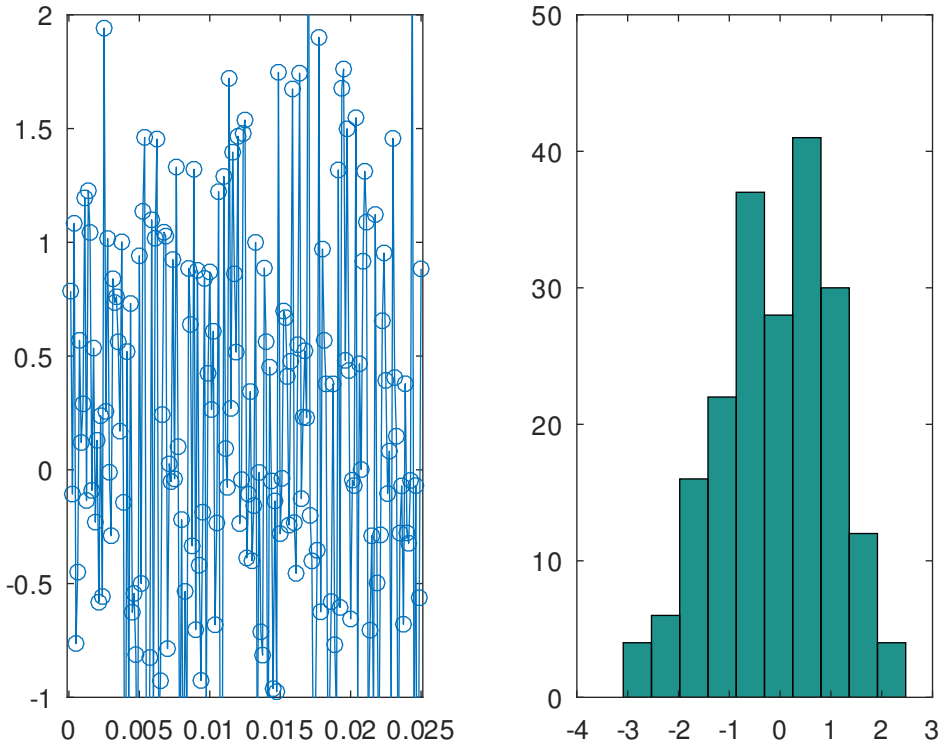
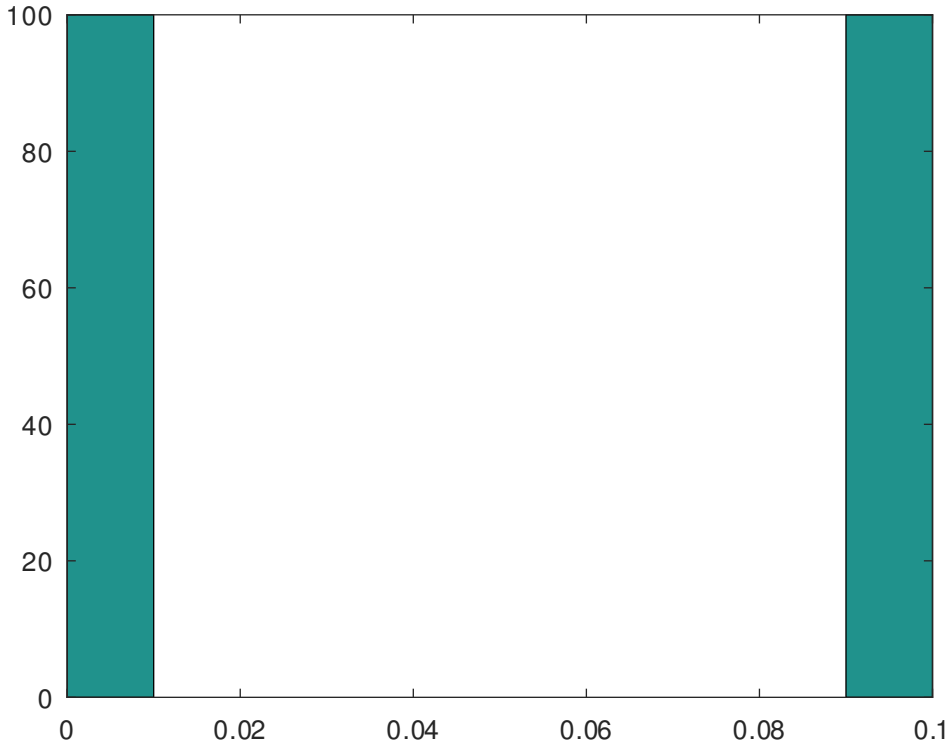
```
clear;
home;
close;

function retval = square_wave(x)
        n_max = length(x);
        retval = zeros(size(x));
        for i=[1:n_max]
        n = floor(x(i)/pi);
        retval(i) = mod(n,2);
        endfor
endfunction

function retval = triangle_wave(x)
        n_max = length(x);
        retval = zeros(size(x));
        for i=[1:n_max]
        retval(i) = mod(x(i)/pi,1);
        endfor
endfunction

function retval = gauss_noise(x)
        retval = randn(size(x));
endfunction
%DSP parameters
f = 400.0;
T = 1/f;
fs = 8000.0;
dt = 1/fs;
t_start = dt;
t_end = 10*T;
t = t_start:dt:t_end;
x = 2*pi*f*t;
figure(1)
subplot(1,2,1)
plot(t,square_wave(x),'-o')
axis([-dt 10*T+dt -1 2])
subplot(1,2,2)
hist(square_wave(x))
print -dpdf "plot1.pdf"
figure(2)
subplot(1,2,1)
plot(t,triangle_wave(x),'-o')
axis([-dt 10*T+dt -1 2])
```

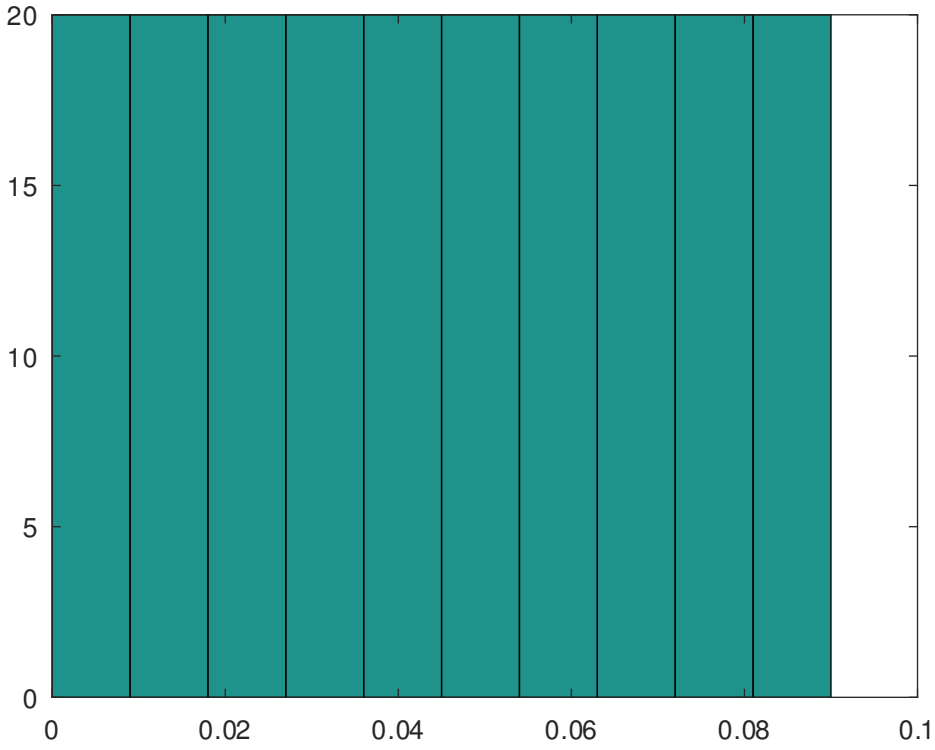
```
subplot(1,2,2)
hist(triangle_wave(x))
print -dpdf "plot2.pdf"
figure(3);
subplot(1,2,1)
plot(t,gauss_noise(x),'-o')
axis([-dt 10*T+dt -1 2])
subplot(1,2,2)
hist(gauss_noise(x))
print -dpdf "plot3.pdf"
figure(4)
hist(square_wave(x)/10)
std(square_wave(x)/10)
mean(square_wave(x)/10)
print -dpdf "plot4.pdf"
figure(5)
hist(triangle_wave(x)/10)
std(triangle_wave(x)/10)
mean(triangle_wave(x)/10)
print -dpdf "plot5.pdf"
figure(6)
hist(gauss_noise(x)/10)
std(gauss_noise(x)/10)
mean(gauss_noise(x)/10)
print -dpdf "plot6.pdf"
```

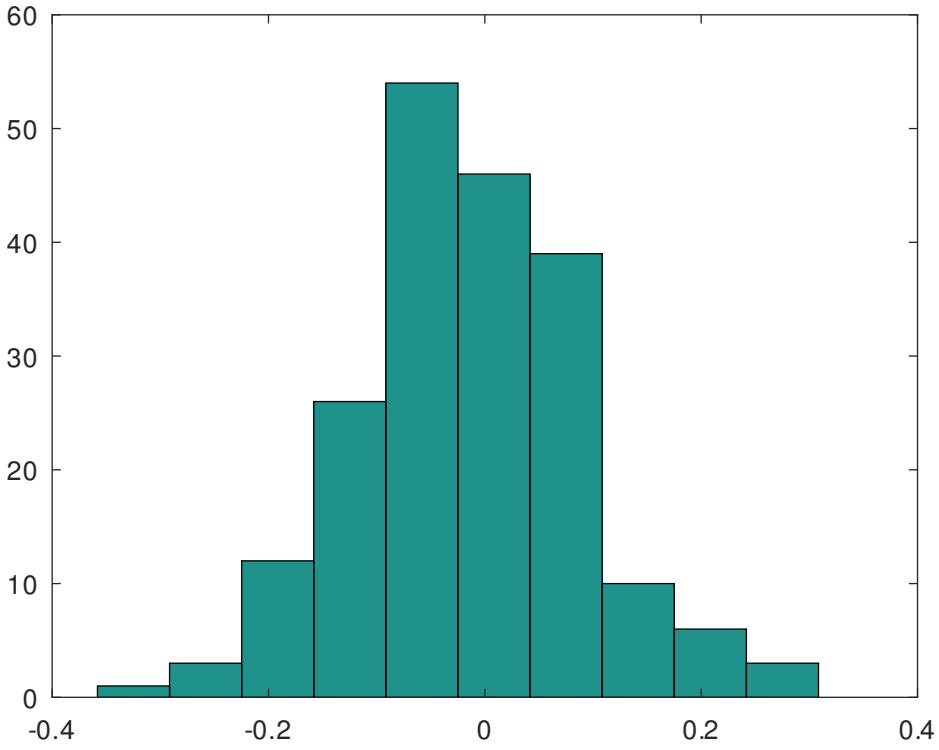

2
1.5
1
0.5
0
-0.5
-1
0
0.005
0.01
0.015
0.02
0.025
100
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1


2
1.5
1
0.5
0
-0.5
-1
0
0.005
0.01
0.015
0.02
0.025
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1


2
1.5
1
0.5
0
-0.5
-1
0
0.005
0.01
0.015
0.02
0.025
50
40
30
20
10
0
-4
-3
-2
-1
0
1
2
3


100
80
60
40
20
0
0
0.02
0.04
0.06
0.08
0.1


20
15
10
5
0
0
0.02
0.04
0.06
0.08
0.1


60
50
40
30
20
10
0
-0.4
-0.2
0
0.2
0.4

1 ADC

a) $\frac{2.55}{255} = 0.01 = \Delta V$

b) $\frac{4.095}{4095} = 0.01 = \Delta V$

c) $\Delta V = 0.001V$

$\frac{12}{P} = 0.001 \quad \frac{12}{0.001} = 12000$

$\log_2(12000) \approx 14$

14 bits

d) $\frac{2.52}{5} = 0.504$

$0.504 \cdot 2048 \approx 1032$

DAC

a) $256 \cdot 0.0048 = 2.3088V$

b) $\frac{2048}{4095} \cdot 5 = 2.5V$

c) $\frac{128}{511} V_{max} = 0.25$

$V_{max} = \frac{511 \cdot 0.25}{128} = 0.998V$

2) a) $500\,KHz \geq 100\,KHz$ $50\,KHz$

b) $500\,KHz \geq (250)\cdot 2\,KHz$ $250\,KHz$

c) $\frac{750}{500} = 1.5$ $250\,KHz$

$f = 1$

$f_s = 1.5$

d $\frac{1000}{500} = 2$ $0\,KHz$

3) $R(f) = \frac{1}{1+jwT}$ $\frac{1-jwT}{1-jwT} = \frac{1-jwT}{1+(wT)^2}$

$$|R(f)| = \sqrt{\left(\frac{1}{1+(wT)^2}\right)^2 + \left(\frac{-wT}{1+(wT)^2}\right)^2}$$

$$= \sqrt{\frac{1+(wT)^2}{(1+(wT)^2)^2}} = \frac{1}{1+(wT)^2}$$

$V_{out} = |R(f)|\, V_{in}$

$wT = 2\pi f RC$

$$\frac{\sqrt{\frac{V_{in}}{V_{out}} - 1}}{2\pi f R} = C \qquad \frac{\sqrt{\frac{3.3}{0.33} - 1}}{2\pi \cdot 1\times 10^{7} \cdot 1\times 10^{3}} = C$$

$$\frac{3}{2\pi \times 10^{11}} = 4.77\times 10^{-12}\,F$$

$$R(f) = \frac{j\omega\tau}{1+j\omega\tau}\cdot\frac{1-j\omega\tau}{1-j\omega\tau} = \frac{j\omega\tau+(\omega\tau)^2}{1+(\omega\tau)^2}$$

$$|R(f)| = \sqrt{\left(\frac{\omega\tau}{1+(\omega\tau)^2}\right)^2+\left(\frac{(\omega\tau)^2}{1+(\omega\tau)^2}\right)^2}$$

$$= \frac{\sqrt{(\omega\tau)^2+(\omega\tau)^4}}{\sqrt{(1+(\omega\tau)^2)^2}}$$

$$= \sqrt{\frac{(\omega\tau)^2(1+(\omega\tau)^2)}{(1+(\omega\tau)^2)^2}} = \frac{\sqrt{(\omega\tau)^2}}{\sqrt{1+(\omega\tau)^2}} = \frac{\omega\tau}{\sqrt{1+(\omega\tau)^2}}$$

$$V_{out} = |R(f)|\,V_{in}$$

$$\frac{V_{out}}{V_{in}} = \frac{\omega\tau}{\sqrt{1+(\omega\tau)^2}}$$

$$\frac{V_{in}}{V_{out}} = \sqrt{\frac{1}{(\omega\tau)^2}+1}$$

$$\left(\frac{V_{in}}{V_{out}}\right)^2 - 1 = \frac{1}{(\omega\tau)^2}$$

$$\frac{2\pi fR}{\sqrt{\left(\frac{V_{in}}{V_{out}}\right)^2-1}} = \frac{1}{2\pi f\tau}$$

$$\frac{2\pi \cdot 1\times10^7 \cdot 1\times10^{-4}}{\sqrt{\left(\frac{3.3}{0.33}\right)^2-1}} = 6.3\times10^{-10}\ F$$