FOUNDATIONS OF SIGNALS AND SYSTEMS
9.3 Solved exercises
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Exercises 9.3

Solve the following MatLab problem:

1. Plot the signal $s_1(t) = \tanh(t)$, as well as its time-shifted versions, $s_2(t) = \tanh(t-b)$ and $s_3(t) = \tanh(t+b)$ with $b = 3$, in the same plot in the time range $[-10, 10]$.
2. Plot the one-sided exponential $s(t) = e^{-1}\,1(t)$ in the range $t \in [-1, 10]$.
3. Draw the (periodic) square-wave of period $T_p = 3$ and duty cycle $d = .3$ in the interval $t \in [-4, 5]$.

Solution.

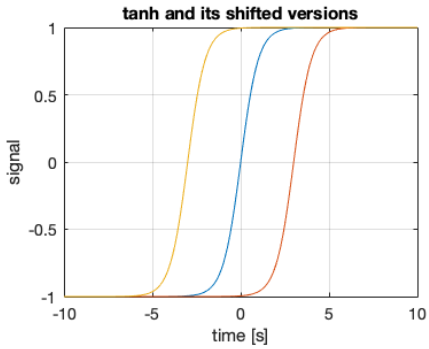
1. The code can be pretty simple, the fundamental aspect being that of correctly choosing a sampling spacing sufficiently small to capture the hyperbolic tangent shape. In the code example this is set to 0.1. The code can then read as follows

```
close all
clear all
clc

t = -10:.1:10;
b = 3;
s1 = tanh(t);
s2 = tanh(t-b);
s3 = tanh(t+b);
figure
plot(t,s1,t,s2,t,s3)
grid on
xlabel('time [s]')
ylabel('signal')
title('tanh and its shifted versions')

% printing figure in png format
set(gcf,'PaperUnits','inches','PaperPosition',[0 0
    4 3])
print -dpng ex9_3_1.png -r100
```

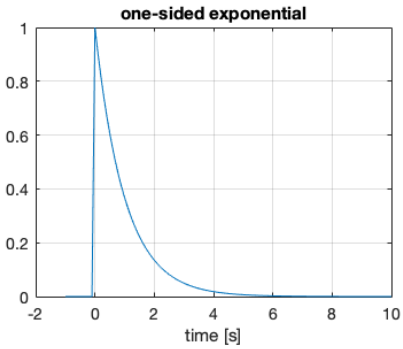
   where the last part of the code is used to export the plot in png format. This provides the following output



2. In this case we can use the vector $t \geq 0$ to set to 0 values at negative times, to have the following result.

```
t = -1:.1:10;
s = (t>=0).*exp(-t);
figure
plot(t,s)
grid on
xlabel('time [s]')
title('one-sided exponential')
```

where the last part of the code is used to export the plot in png format. This provides the following output



3. In this case we define a function for the square wave depending on parameters T_p (period) and d (duty cycle). This builds on the definition of rect, which is defined according to the absolute value $|t|$. In the definition of the square wave, note how time is first reported to the period by $t_1 = t/T_p \pmod 1$, then we exploit the fact that in the reference period the signal behaves as $\text{rect}(t/d) + \text{rect}((t-1)/d)$.

```
t = -4:.01:5;
s = square_wave(t,3,.3);
figure
```

```
plot(t,s)
grid on
xlabel('time [s]')
title('square-wave')
axis([xlim -.1 1.1])

function s = square_wave(t,Tp,d)
t1 = mod(t/Tp,1);
s = rect(t1/d) + rect((t1-1)/d);
end

function s = rect(t)
s = (abs(t)<.5)+.5*(abs(t)==.5);
end
```