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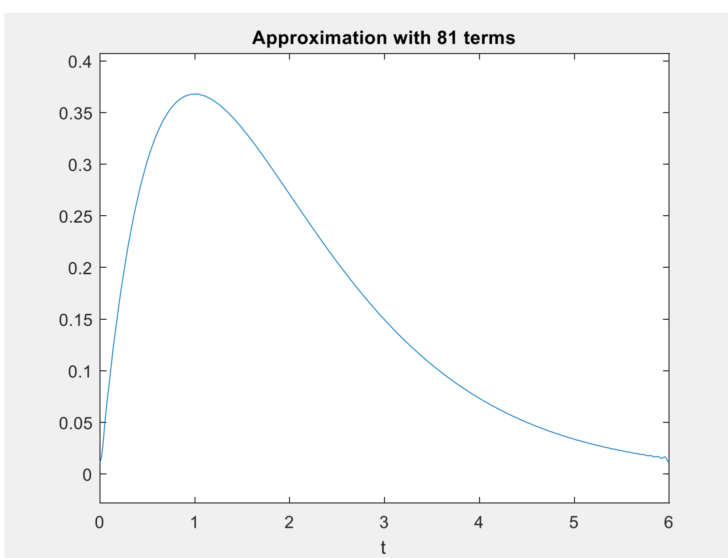
Lab 10

Task 1:

Code:

```
T = 6;
t0 = 0;
w = 2*pi/T;

syms t
x = t.*exp(-t);

a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:80
b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
end
for n = 1:80
c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k = 1:80;
xx = a0+sum(b.*cos(k*w*t))+sum(c.*sin(k*w*t));
ezplot(xx, [t0 t0+T]);
title('Approximation with 81 terms')

```

Graph:

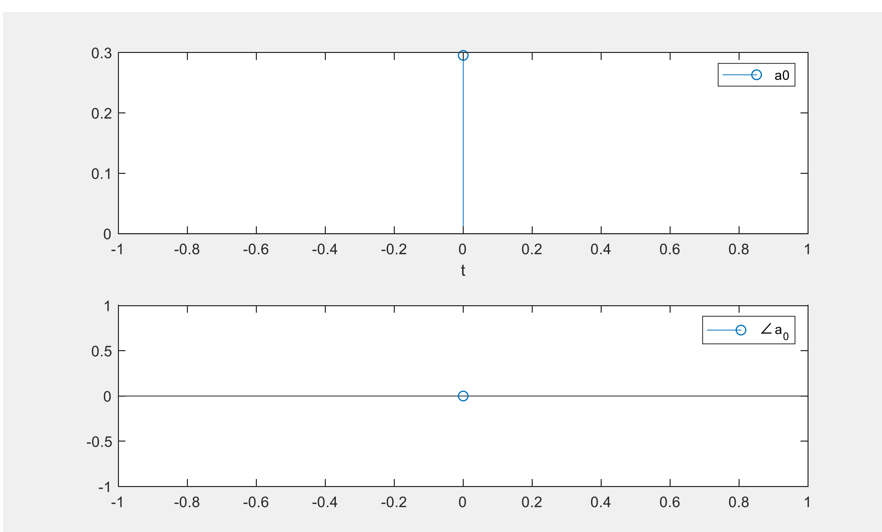


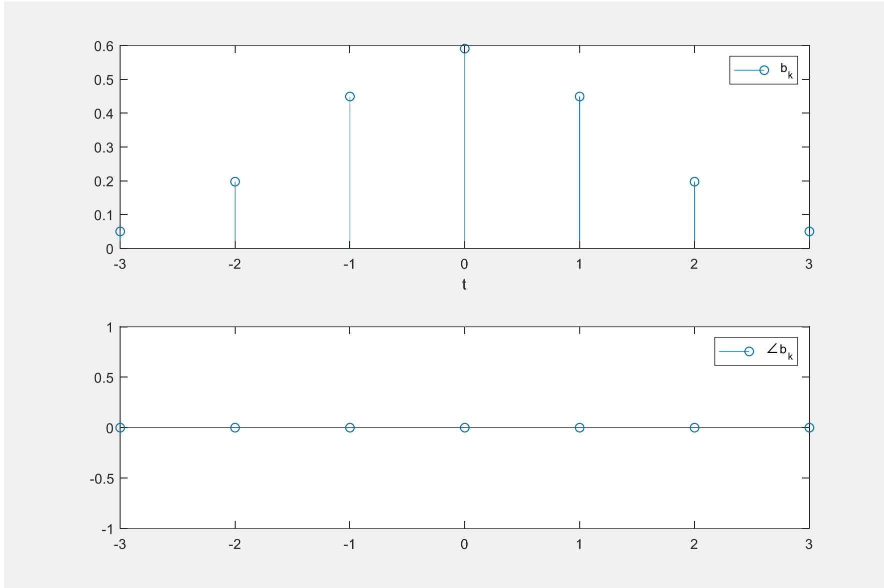
Task 2:

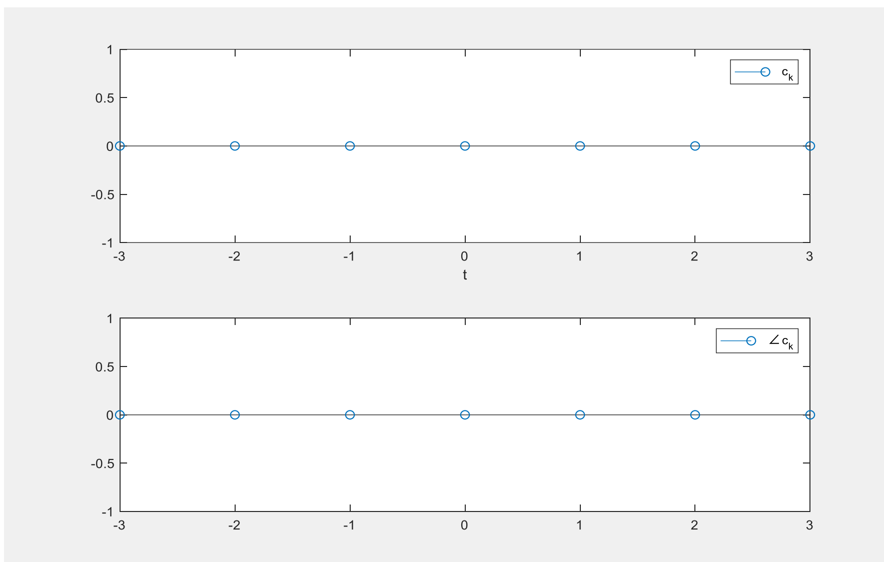
Code:

```
T = 6;
t0 = -3;
w = 2*pi/T;

syms t
x = exp(-t.^2);
n = -3:3;
a0 = (1/T)*int(x,t,t0,t0+T);

b = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);

c = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);

subplot(2,1,1);
stem(0,abs(a0));legend('a0');
subplot(2,1,2);
stem(0,angle(a0));legend('\angle a_0');
figure();

subplot(2,1,1);
stem(n,b);legend('b_k');
subplot(2,1,2);
stem(n,angle(b));legend('\angle b_k');
figure();

subplot(2,1,1);
stem(n,c);legend('c_k');
subplot(2,1,2);
stem(n,angle(c));legend('\angle c_k');
```

Graph:







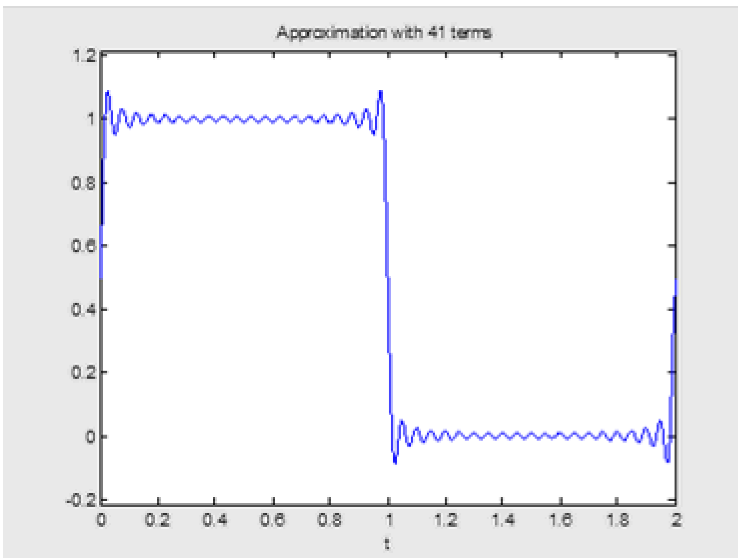
Task 3:

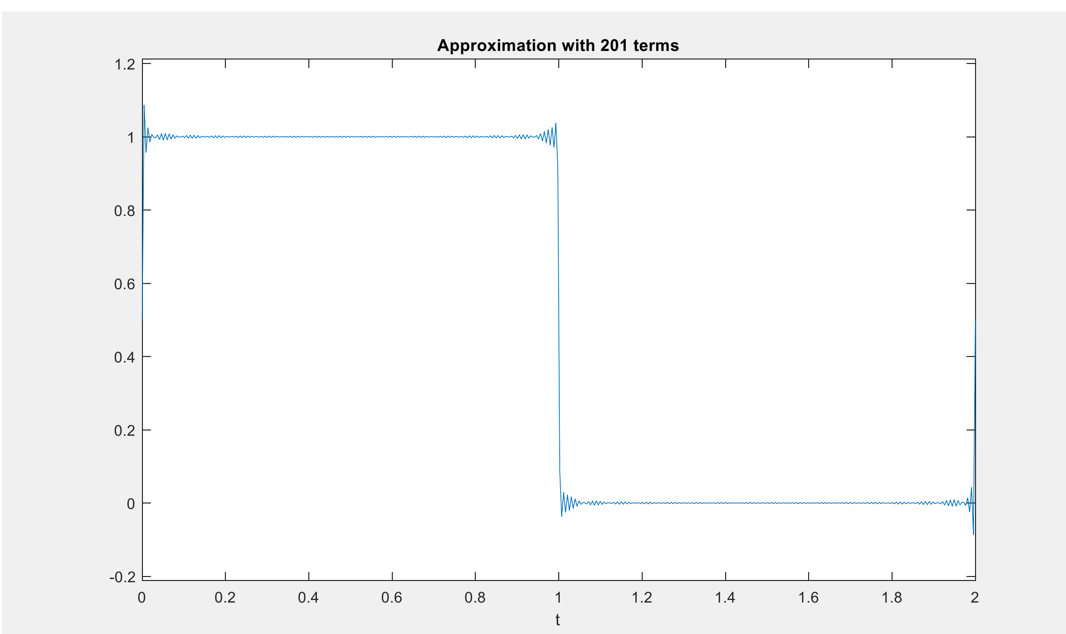
Code:

```
t0 = 0;
T = 2;
w = 2*pi/T;
syms t
x=heaviside(t)-heaviside(t-1);

a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:40        %Approximation using 41 terms
    b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
end
for n = 1:40        %Approximation using 41 terms
    c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end

k = 1:40;           %Approximation using 41 terms
xx = a0 + sum(b.*cos(k*w*t)) + sum(c.*sin(k*w*t));
ezplot(xx, [t0 t0+T]);
title('Approximation with 41 terms')
```

```
t0 = 0;
T = 2;
w = 2*pi/T;
syms t
x=heaviside(t)-heaviside(t-1);
a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:200
    b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
    c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k = 1:200;
xx = a0 + sum(b.*cos(k*w*t)) + sum(c.*sin(k*w*t));
ezplot(xx, [t0 t0+T]);
title('Approximation with 201 terms')
```

Graph:





Task 4:

Code:

```
T = 2;
t0 = 0;
w = 2*pi/T;
syms t
x = heaviside(t)+((heaviside(t-1)).*(1-t));
ezplot(x,[t0 t0+T]),grid on
```

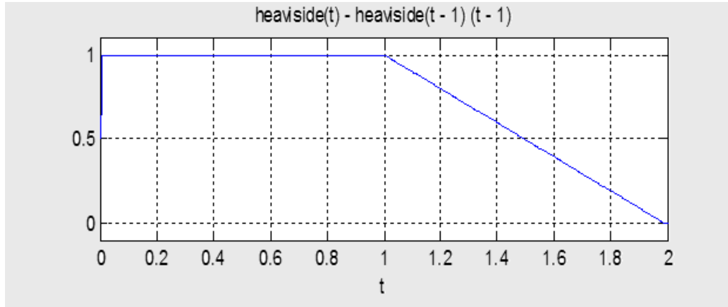
```
a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:2
b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k = 1:2;
xx1 = a0 + sum(b.*cos(k*w*t)) + sum(c.*sin(k*w*t))
ezplot(xx1, [t0 t0+T]);
title('Approximation with 3 terms')
```

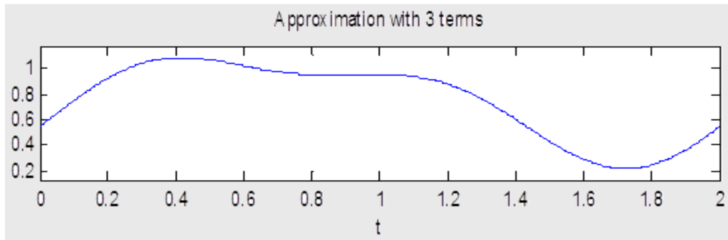
```
a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:4
b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k = 1:4;
xx1 = a0 + sum(b.*cos(k*w*t)) + sum(c.*sin(k*w*t))
ezplot(xx1, [t0 t0+T]);
title('Approximation with 5 terms')
```

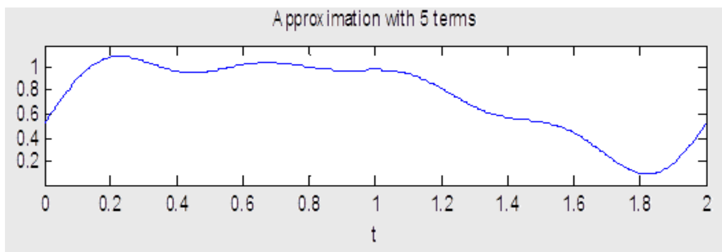
```
a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:6
b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k = 1:6;
xx1 = a0 + sum(b.*cos(k*w*t)) + sum(c.*sin(k*w*t))
ezplot(xx1, [t0 t0+T]);
title('Approximation with 7 terms')
```

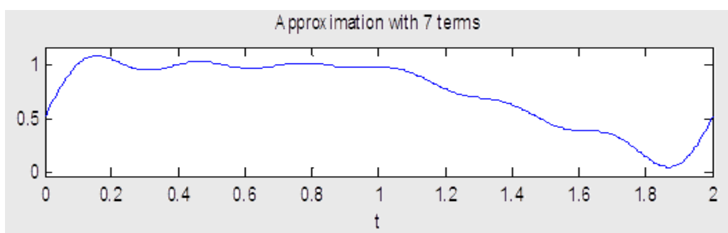
```
a0 = (1/T)*int(x,t,t0,t0+T);
for n = 1:16
b(n) = (2/T)*int(x*cos(n*w*t),t,t0,t0+T);
c(n) = (2/T)*int(x*sin(n*w*t),t,t0,t0+T);
end
k = 1:16;
xx1 = a0 + sum(b.*cos(k*w*t)) + sum(c.*sin(k*w*t))
ezplot(xx1, [t0 t0+T]);
title('Approximation with 17 terms')
```

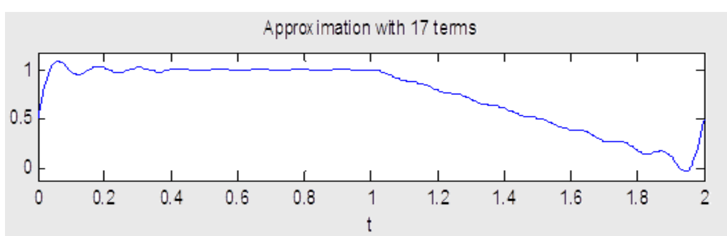
Graph:


heaviside(t) - heaviside(t - 1) (t - 1)
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
t


Approximation with 3 terms
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
t


Approximation with 5 terms
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
t


Approximation with 7 terms
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
t


Approximation with 17 terms
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
t

Critical Analysis:

In this lab I learnt:

- $x(t)$, by using the trigonometric Fourier series, can be expressed in time interval $[t_0, t_0 + T]$ as a sum of sinusoidal signals.
- A shift in time of the periodic signal results on a phase change of the Fourier series coefficients. So, if $x(t) \rightarrow a_k$, the exact relationship is

$$x(t - t_1) \leftrightarrow e^{-jk\Omega_0 t_1} a_k$$

- The Fourier series coefficients of the reflected version of a signal $x(t)$ are also a reflection of the coefficients of $x(t)$. So, if $x(t) \rightarrow a_k$, the mathematical expression is

$$x(-t) \leftrightarrow a_{-k}$$

- The Fourier series coefficients of a time scaled version $x(\lambda t)$ and $x(t)$ do not change. On the other hand, the fundamental period of the time scaled version becomes T/λ

The Fourier series coefficient of the product of two signals equals the convolution of the Fourier series coefficients of each signal.

THE END