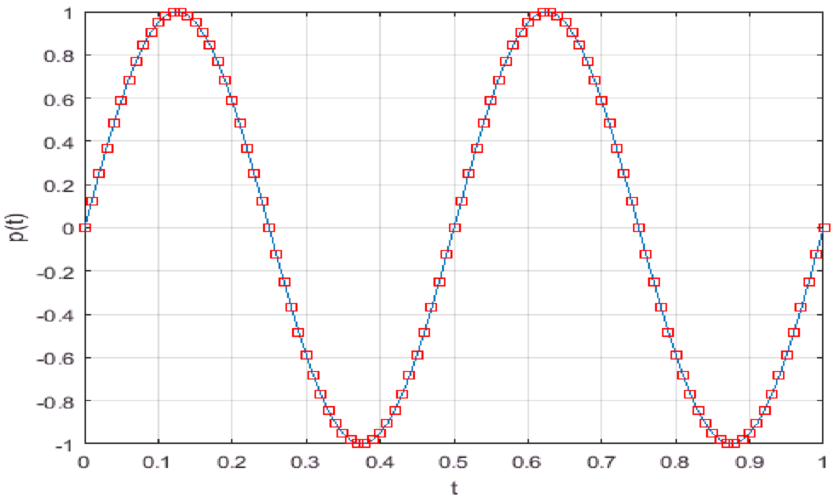
SiSy Short-Exam-1:

Duration: 45 Minutes Open book exam, without calculator. Your calculations and solution approach need to be readable and comprehensible in order to get the full points. Please write your final results in the reserved gray fields and use the provided spaces for the sketches. Do not forget to label your axes.

Name:					Class:	
1:	2:	3:	4:	5:	Points:	Grade:

Exercise 1 *Complex Exponentials* *[3 Points].*

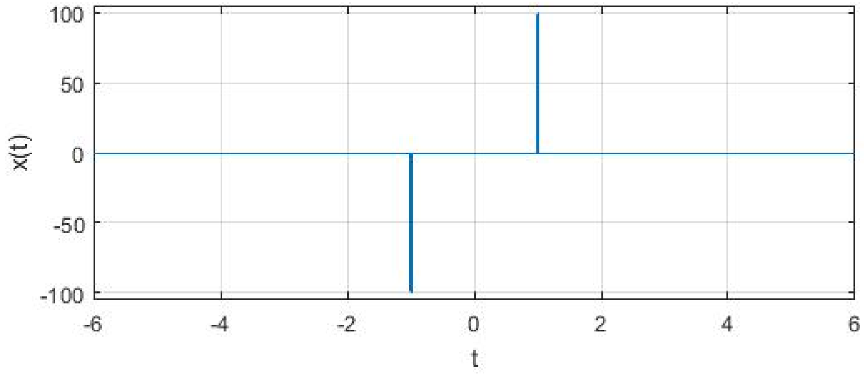
Complete the Matlab code, which generates the plot below. The cosine function p(t) should be once defined using trigonometric functions, and once using complex exponentials. Plus reuse the function φ(t) (in the code called phi_t) where possible.




```
                          % fresh start
t = 0:1e-2:1;
phi_t = 
p_t     = cos(phi_t);
p_t_bis = 
plot(t,p_t), grid on, hold on
plot(t,p_t_bis,'rs'),hold off, xlabel('t'),ylabel('p(t)')
```

Exercise 2 *Impulse and Steps Functions* *[4x3=12 Points]*.

A sketch of the time function x(t) is given below:



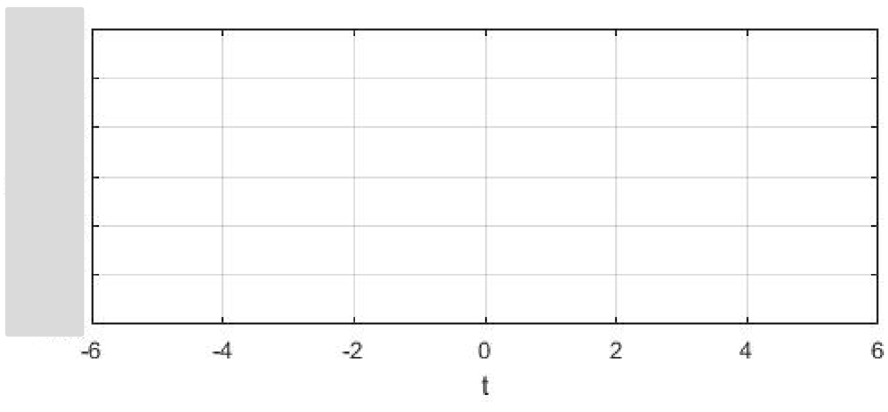
(a) Determine the equation describing x(t) . Hint: it is a combination of impulse functions.

x(t) = ?

(b) The function y(t) is the integral over time of x(t) . Complete the equations defining y(t):

$$y(t) = \int_{-\infty}^{t} x(\lambda)\, d\lambda = ?$$

(c) Prepare a sketch of the function y(t) . Do not forget to label your axes.

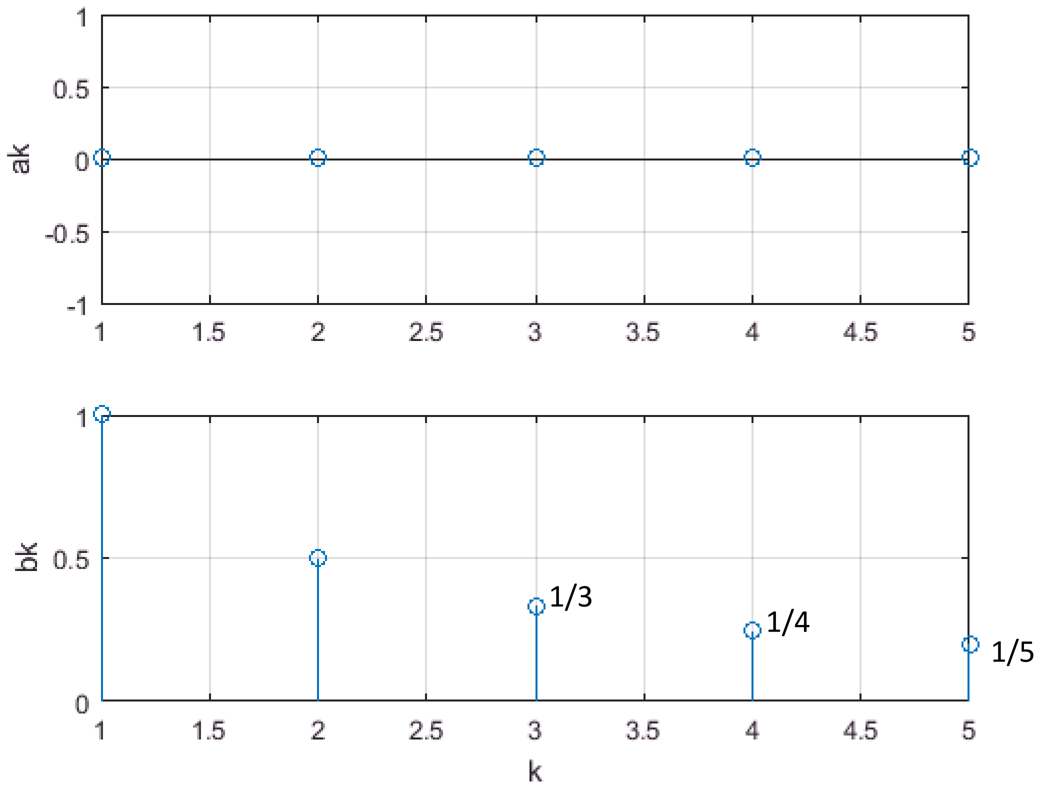


(d) You want to define now a periodic function, $y_p(t)$, which has the same form as y(t) in the interval [-2,+2], but repeats its shape every 5 seconds.
Determine the equation describing $y_p(t)$. Hint: use the sum sign.

$y_p(t) = ?$

Exercise 3 *Fourier Series and Spectrum* *[3+2+3+2=10 Points].*

The spectrum of a periodic time function y(t) is given below (real Fourier coefficients ak and bk). The fundamental frequency f_0 = 1Hz . T



(a) Write the equation of the time function y(t) . Hint: the sum of the harmonics is expected.

x(t) = ?

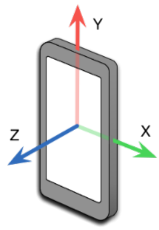
(b) Is y(t) an even or an odd function? Why? Please justify your answer.

(c) Determine the equation describing the complex ck coefficients. Check if the equation you determined is valid for all k integer values, otherwise extend your description.

(d) Which form do you expect to be approximated by y(t) ? Please justify your answer (e.g. you can reference the exercise/lab where you tried this out)

Exercise 4 *IMU Mobile Sensors* *[2x3=6 Points].*

A person moves his/her telephone as shown in the figure below.



Source: http://blog.contus.com/how-to-measure-acceleration-in-smartphones-using-accelerometer/

(a) In which sensors do you expect to see the largest variations?
Please indicate accelerometer or gyrometer, and on which axis.

(b) How can you retrieve from the gyrometer data the tilt (inclination) angle of this movement? Please answer with a short sentence and 2-3 lines of Matlab Code (the lines doing the central part of the "job").

And if you have time left and want to gather further points, go for the challenge question below:

Exercise 5 *Sign and Square functions* *[2+3+4=9 Points].*

The Matlab code from exercise 1 shall be extended to generate a square wave based on the cosine function p(t) already described in the code.

You should use for this the function sign(), which description is listed below:

--- help for sign ---

sign Signum function.
For each element of X, sign(X) returns 1 if the element is greater than zero, 0 if it equals zero and -1 if it is less than zero.
For the nonzero elements of complex X, sign(X) = X ./ ABS(X).

(a) Use the sign function to describe in Matlab a square wave with same period as p(t) and duty cycle 50%. Call your function s_t_d50 .
Hint: expect as an answer 1 or 2 lines of Matlab code

(b) Use the sign function to describe in Matlab a square wave with same period as p(t) and duty cycle 25%. Call your function s_t_d25 .
Hint: expect as an answer 1 or 2 lines of Matlab code

(c) If you would calculate the complex Fourier coefficients for s_t_d50 and s_t_d25 . Which coefficients would be equal to zero? Why is it so? Please justify your answer!
Hint: you should not calculate the coefficients, but predict the zero-crossings on the spectrum.