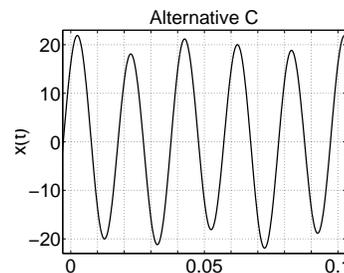
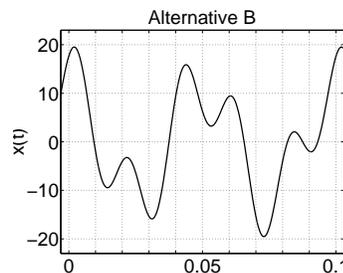
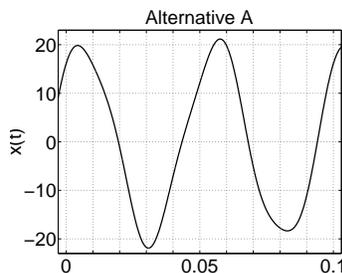


You are not allowed to use a math reference book nor any calculator. Formulae given in a separate paper.

1. (6p) Statements, reply either TRUE (T) or FALSE (F). A correct answer +1 points, a wrong -1 points. Reply to as many statements as you want. However, the maximum number of points is six and minimum zero.
  - a) The complex conjugate of the complex number  $e^{-13\pi j/4}$  is  $-0.7071 - 0.7071j$  (with the precision given in the formulae paper).
  - b) Signal  $x(t) = \cos(10\pi t) + \cos(10t)$  is periodic.
  - c) Sequences  $x_1[n] = e^{3\pi j n/8} + e^{-3\pi j n/8}$  and  $x_2[n] = \sin(3\pi n/8 + \pi/16)$  have the same fundamental period.
  - d) The output  $y[n]$  of a causal LTI system is zero for all  $n < 0$ .
  - e) The impulse response of a moving average filter with four points is given by  $h[n] = 0.25\delta[n] + 0.25\delta[n-1]$ .
  - f) Convolution of sequences  $x_1[n] = 3\delta[n] + 2\delta[n-1]$  and  $x_2[n] = -\delta[n] + 2\delta[n-1]$  is  $x[n] = x_1[n] * x_2[n] = -3\delta[n] + 4\delta[n-1] + 4\delta[n-2]$ .
  - g) The Fourier transform of the convolution of the signal  $x(t) = e^{-t}u(t)$  and the impulse response  $h(t) = e^{-5t}u(t)$  is  $Y(j\omega) = 1/(5 + 6j\omega - \omega^2)$
  - h) The inverse transform of the spectrum  $Y(j\omega) = e^{-2j\omega}/(1 + 0.3j\omega)$  is  $y(t) = e^{-0.3(t-2)}u(t-2)$
  - j) The Fourier transform  $H(j\omega)$  of the impulse response  $h(t)$  is computed by multiplying impulse response by  $e^{-j\omega t}$ .
  
2. (6p) Consider a discrete-time system, whose input-output-relationship is  $y[n] = 0.5x[n+2] + 0.5x[n+1]$ .
  - a) Is the system linear? Is it time-invariant? Is it causal? Explain briefly.
  - b) If the input is  $x[n] = 3\delta[n+1] - 2\delta[n]$ , what is the output  $y[n]$ ?
  - c) If the output is  $y[n] = \delta[n] - \delta[n-2]$ , what is the input  $x[n]$ ?
  
3. (6p) Non-zero Fourier-series coefficients of a periodic continuous-time signal are  $a_{-5} = -10j$ ,  $a_{-2} = 1$ ,  $a_2 = 1$ ,  $a_5 = 10j$ . The fundamental angular frequency is  $\omega_0 = 20\pi$  (rad/s).
  - a) What is the fundamental period of the signal?
  - b) What is the representation of the signal  $x(t)$  using cosine/sine functions?
  - c) Which figure below does represent the signal mostly? Explain briefly. In the x-axis there is time in the interval  $-0.003$  s ...  $0.103$  s .



4. (6p) The number of students attending exercises weekly during this spring is given in the table below.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
The number of students weekly:	141	114	93	59	62	47

Design a simple (as simple as possible), causal LTI system, which computes weekly differences of the amount of students in exercises.

- a) Write down the difference equation.
- b) Sketch the block (flow) diagram of the system.
- c) What is the impulse response of the system?
- d) What is the output sequence for an input given in the table above?