EDISP 2010/2011 – Test 1, 14.12.2010 **version B**

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Name:_____

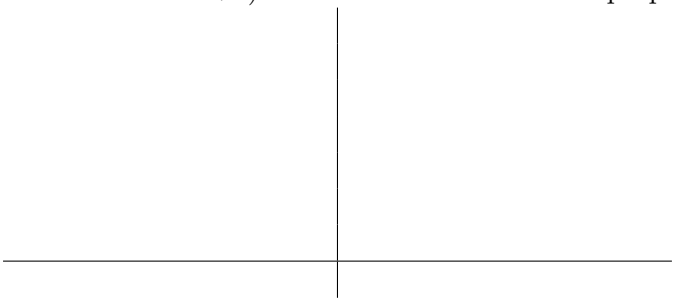
For short problems, try to write the answer in the provided space. Put your calculations and longer solutions on the reverse or on an additional sheet marked with your name.

1. DT system T_1 is linear and stable. A system T_2 is described as $T_2(x[n]) = T_1(x[n]) - 2 \cdot x[n]$
   (a) (1 p.)is T_2 stable? yes/no: [ ] . Present proof on the reverse side.
   (b) (2 p.)is T_2 linear? yes/no: [ ] . Present proof on the reverse side.

2. (2 p.) A CT signal $x_{ct}(t) = cos(2\pi 17\ t)$ was sampled producing $x(n) = x_{ct}(\frac{n}{50})$.
   (a) Calculate normalized frequency f_n and normalized angular frequency θ of $x[n]$.
   Answer: $f_n =$ [ ], $\theta =$ [ ]. Calculation: .....
   .....
   (b) What is the period of $x[n]$? Answer: [ ]. Calculation: .....
   .....

3. (2 p.) A single arithmetic operation (+, ·) with real arguments consumes 1 pJ (picoJoule) of energy in a certain signal processing hardware.
   (a) How much energy does it take to calculate a single "butterfly"? Answer: [ ]. Calculations: .....
   .....
   (b) How much energy does it take to calculate a 1024-point FFT? Answer: [ ]. Calculations:
   .....

4. (2 p.) Let $x[n]$ be defined as $x(n) = \delta(n-2) + \delta(n) + \delta(n+2)$. Plot (on one picture) the amplitude of Fourier transform of $x[n]$ and the 8 point DFT of $x[n]$ (assume the DFT summation interval from $n = -4$ to $+3$) Mark the horizontal axis apropriately for both cases.



5. (1 p.) A signal $x[n]$ is a rectangular impulse with length of $L = 16$ samples. An LTI system is described by an impulse response $h(n) = \sum_{k=0}^{8} \delta(n-k)$. Calculate maximum possible number of nonzero samples in the response of the system $h[n]$ to signal $x[n]$. Answer: [ ].
   Calculations: .....

6. (2 p.) An LTI system has an impulse response $h(n) = u(n) \cdot -(a^n)$ $(-1 < a < 0)$. Calculate step response $k(n)$ of the system. Hint: $\sum_{k=0}^{N-1} q^k = (1 - q^N)/(1 - q)$.
   Answer or plot: .....
   Calculation: .....

$\Sigma = 12p\ T = 45\ min$