LUNDS TEKNISKA HÖGSKOLA
Inst. för Elektro- och Informationsteknik

Signal Processing in Multimedia, EITA50, 2017
Task 2 (out of 2)

Deadline: Complete the task before until Tuesday, 31:st of Oct, at 18:00.

Observe: In order to simplify the correction:
-Only solve one problem per paper sheet.
-Please write your name on every paper sheet.
Statements must be motivated by reasoning and/or equations.
The points from the tasks will be added to the examination score.
Max Tot. score (exam + 2 tasks) = 5.0 + 0.5 + 0.5 = 6.0
Grading; 3 (≥3.0p), 4 (≥4.0p), 5 (≥5.0p).

1. The following discrete time signals are given.

$$x_1(n) = [\,-2 \quad \underset{\uparrow}{-1} \quad 0 \quad -1 \quad -2\,], \quad x_2(n) = [\,-\underset{\uparrow}{1} \quad 2 \quad -2 \quad -1 \quad 1 \quad -1\,]$$

   Determine the following (3 out of 4 correct answers gives full points) **(0.2p)**

   a) The linear convolution between the sequences, i.e. $y(n) = x_1(n) * x_2(n)$.

   b) The circular convolution modulo 4 between the sequences, i.e. $y(n) = x_1(n) \circledast_4 x_2(n)$.

   c) The linear correlation between the sequences, i.e. $y(n) = x_1(n) * x_2(-n)$.

   d) The circular correlation modulo 5 between the sequences, i.e. $r_{x_1x_2}(n) = x_1(n) \circledast_5 x_2(-n)$.

2. A horse carriage i traveling at 67.9 km/h (exactly at $6 \times 3.6 \times \pi$ km/h) in a direction such that the wheels are rotating counter-clockwise. Every wheel has 8 spokes and a diameter or 1 m. The wheels are recorded with a digital video camera that takes 50 pictures/second. What observed rotational speed (in revolutions per second) will the wheels have by observing the recorded digital sequence? What rotational direction will be observed, clock-wise or counter-clockwise? Also, what horse carriage speed does this rotational speed correspond to? **(0.1p)**

3. Signals are sampled, down-sampled or up-sampled and reconstructed ideally according to the items below. Determine what the resulting signal will be.

   a) The signal $\cos(2\pi 300t)$ is sampled using $F_s = 1000$ Hz, down-sampled by a factor 4 (i.e. only every fourth sample value is kept), and then ideally reconstructed with a sample rate of $F_s = 1000$ Hz). **(0.1p)**

   b) The signal $\cos(2\pi 2100t)$ is sampled using $F_s = 800$ Hz, up-sampled by a factor 3 (i.e. after every sample value two zeroes are inserted), and then ideally reconstructed with a sample rate of $F_s = 600$ Hz. **(0.1p)**