SURNAME:	NAME:	DNI:	GRADE:
COURSE: Random Signals (Señales Aleatorias)	DATE: 14/06/2018	GROUP:	

Final exam training
Length: 3 hours

FINAL EXAM TRAINING

The following learning outcomes will be assessed in this exam:

LO1 *Analytically solve problems related to* ***probability theory and random variables***
LO2 *Analytically solve problems related to* ***random processes***
LO3 *Analytically solve problems related to* ***optimal filtering, detection and prediction of random signals***
LO4 *Analytically solve problems related to* ***information theory***

LO1 LO2

1. Given two biomedical signals modeled as random processes $X(t) = Acos(\omega_0 t + \Phi/2)$ and $Y(t) = ABcos(\omega_0 t + \Phi/2)$, where A and ω_0 are real constants and Φ and B are independent random variables $(\Phi \sim U(0,4\pi), B \sim U(-1,0))$.

   a. Check if *X(t)* and Y(t) are wide-sense stationary.
   b. Check if *X(t) and Y(t)* are jointly wide-sense stationary.
   c. Check if X(t) if ergodic in the mean and the autocorrelation.
   d. Given $Z(t) = X(t) + N_2(t)$, being $N_2(t) = N_1(t) \star h(t)$ with $S_{N_1 N_1}(\omega) = N_0/2$ and $H(\omega) = FT\{h(t)\} = 1, |\omega| < 1$. Compute the SNR of *Z(t)*

LO1 LO4

2. Given a random variable X with the following symbols and probabilities:

	X0	X1	X2	X3	X4
P(X)	0.1	0.15	0.65	0.05	0.05

   a. Obtain a Huffman code and analyze the quality of the coding in terms of the mean code length with respect to the entropy.

LO1 LO4

3. Given a family of communication channels defined by:
   P(Y=0 | X=0)=a
   P(Y=1 | X=0)=1-a
   P(Y=1 | X=1)=b
   P(Y=2 | X=1)=1-b
   a. Compute the channel capacity if a=b=1.
   b. Compute the channel capacity if a=b=1/2.

LO2 LO3

4. Write the first 4 values of of vector $\overrightarrow{w(n)}$ of a 4-coefficient LMS filter, given the initial vector is $\vec{w}(0) = [1\ 1\ 1\ 1]^T$ and $\mu = 0.25$. The primary input and the reference inputs are:

$$\vec{x} = [x(0)\ \ x(1)\ \ldots.]^T =$$
$$[0.1, 1.3, 1.8, 3.1, 2.1, 2.7, -0.3, -1.2, -1.7, -3.2, -2.1, -0.8, 0.2, 0.7, 2.2, 3.1, \ldots\ ]^T$$
$$\vec{r} = [-0.1, -0.3, 0.2, -0.1, -0.1, 0.3, 0.3, -0.2, 0.3, 0.2, 0.1, 0.2, -0.2, -0.3, -0.2, -0.1, \ldots\ ]^T$$

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Consider that all x(n)=0 and r(n)=0 if n<0.

LO2 LO3

5. Given a random process X(t) with cross-correlation

$R_{XX}(-2)$ =0.24649
$R_{XX}(-1)$ =0.24671
$R_{XX}(0)$ =0.27136
$R_{XX}(1)$ =0.24671
$R_{XX}(2)$ =0.24649

Use a 2-coefficient linear predictor to find Sxx(0)/Sxx(0.5)