National Polytechnic School of Oran
Department of Electrical Engineering

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Final test in Signal Processing SP

Court questions 5 pts

What is the stability condition of a digital filter?
What is a linear and time-invariant system?
Define the impulse and step responses of a filter?
Establish Shannon's theorem.
What are the problems encountered in ideal sampling?
Define a recursive, non-recursive system?

Exercice 01 : pts

An invariant and causal linear digital system is excited at its input by the following signal:

$$x(n) = \left(\frac{1}{4}\right)^n u(n) + u(-n-1)$$

Producing at the output, the signal y(n) whose Z transform is $Y(Z) = \frac{-\frac{3}{4}Z^{-1}}{\left(1-\frac{1}{4}Z^{-1}\right)(1-Z^{-1})}$

a- Determine the transfer function H(Z) of the system and its ROC ?
b- Find the output y(n) of the system.

Exercice 02 : pts

Calculate the Z transform of the signal $x(n) = \prod_N(n)$

- By directly applying the definition.
- Using u\left(n\right) and the delay theorem.

Exercice 03 : pts

Let the function $f(t) = e^{-|t|}\sin(t)$

a- Find the Fourier transform of $f(t)$.
b- Sketch the modulus and phase spectra of $f(t)$.

Exercice 04 : pts

Calculate the TFD of the defined sequence $\{f_k\} = \{1,1,0,0,0,0,0,1\}$
Determine the inverse Z transform of

$$X(Z) = \frac{1-3Z^{-5}}{(1-0.2Z^{-1})(1+0.6Z^{-1})} \quad ROC \equiv 0.2 < |Z| < 0.6$$

Exercice 05 : pts

The transfer function of a digital filter has two poles at z = 0, and two zeros at z = −1 and z = 1.

a- Determine the transfer function H(z).
b- Deduce the equation for the differences of the filter.
c- Determine the impulse response of the filter y(n).

Exercice 06: pts

The nth moment of a signal f(t) is given by: $m_n = \int_{-\infty}^{+\infty} t^n f(t)dt$

Using frequency differentiation, show that : $m_n = -j^n \frac{d^n F(0)}{dw^n}$

Perseverance pays off