Signal Theory

1. **Course number and name:** 020THSES2 Signal Theory

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Instructor's or course coordinator's name:** Hadi Sawaya

4. **Text book:**
    a. **Other supplemental materials:**
    Professor textbook and course material

5. **Specific course information**
    a. **Catalog description:**
    This course introduce the basic concepts for analyze and treatment of continuous and discrete-time deterministic signals, as well as continuous and discrete-time random processes. The course covers Fourier transform, Parseval theorem, distributions, Fourier series decomposition for periodic signals, linear time-invariant systems, linear filtering of continuous signals, linear and non-linear distortions, sampling, Z-transform, discrete-time Fourier transform, continuous and discrete random signals, 2^{nd}-order stationarity of continuous and discrete-time random processes, representation of narrow band signals.

    b. **Prerequisites:** 020MATES1 Mathematics, 020PROES1 Probability and Statistics

    c. **Required:** Required for CCE students

6. **Specific goals for the course**
    a. **Specific outcomes of instruction:**
    Analyze and identify the spectral representation of deterministic signals with finite-energy, distributions and periodic signals.
    Recognize the distortions introduced by linear and non-linear filters.
    Analyze and identify the spectral representation of discrete-time deterministic signals.
    Analyze and identify the spectral representation of continuous and discrete-time random processes.
    Determine the statistical properties and the spectral representation of a filtered random process.
    Identify the representations of narrow band signals.

    b. **KPI addressed by the course:**

KPI	a1	a2	e3
Covered		x	x
Assessed	x	x	x
Give Feedback	x	x	x

7. Topics and approximate lecture hours:

Course introduction, (1 Lecture)

Continuous-time deterministic signals, classification representation, finite-energy signals, Fourier transform, properties of the Fourier transform, Parseval theorem, Energy spectrum density, signal space representation (3 lectures)

Distributions, Dirac signal, signe and step signals, Fourier series decomposition for periodic signals, Power spectrum density, Parseval theorem (2 lectures)

Linear-time invariant systems, convolution, causality, stability, linear and non-linear distortions (3 lectures)

Sampling, sampling theorem, reconstitution using a low-pass filter, a zero-order hold and a first-order hold (2 lectures)

Z-transform: definition, convergence, relation with Laplace transform, properties of Z-transform, Calculation of the Z-transform using the Laplace transform, inverse Z-transform : partial fraction decomposition, division by increasing power, Residues method, discrete-time Fourier transform (5 lectures)

Continuous and discrete-time random signal, model, stationarity, ergodicity, 2^{nd}-order stationarity of continuous and discrete-time random processes, power spectrum density, white noise, cyclostationarity, Gaussian processes, linear filtering of 2^{nd}-order stationary processes, interference formula, inter-correlation between the input and the output of a linear filter, examples of linear filters (9 lectures)

Narrow band signals, Hilbert transform, analytical signal, complex envelope, filtering, interference, 2^{nd}-order stationary narrow band random processes (3 lectures)