Signal Theory

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

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

3. **Name(s) of instructor(s) or course coordinator(s):** Hadi Sawaya

4. **Instructional materials:** course handouts; slides; in-class problems

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:** (020AN2NI4 Analysis2 or 020AN3CI4 Analysis 3) and (020AL3CI4 Algebra 3 or 020PRBNI4 Probability)

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

6. **Educational objectives 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. **PI addressed by the course:**

PI	1.1	1.2	1.3	6.3	6.4
Covered	x	x	x	x	x
Assessed			x	x	x

7. **Brief list of topics to be covered**

- 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 (12 lectures).