Signals and Systems

1. **Course number and name:** 020SYSES2 Signals and Systems

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

3. **Instructor's or course coordinator's name:** Tina Yaacoub

4. **Instructional materials:** Course handouts, slides, in class problems.

5. **Specific course information**
   a. **Catalog description:**
   This course covers basic concepts of signal processing and continuous and discrete systems such as the Fourier transform, distributions, Fourier series decomposition of periodic signals, Parseval's theorem, linear and invariant systems, linear filtering of continuous signals, linear and nonlinear distortions, sampling, Z transform, discrete time Fourier transform, truncation windows, discrete Fourier transform (DFT), Fast Fourier (FFT), recursive and non-recursive digital filters, synthesis of recursive and non-recursive filters.
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   b. **Prerequisites:** Analysis 2 (020AN2CI3 or 020CDFNI4)

   c. **Required** for the EE Program.

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.
   - Analyze and identify the spectral representation of distributions and deterministic signals with finite power.
   - Recognize the distortions introduced by linear and non-linear filters.
   - Understand the sampling process, Nyquist condition and the limitations related to sampling frequency, aliasing and reconstitution.
   - Analyze and identify the spectral representation of discrete-time deterministic signals using the Z-transform and the Fourier transform.
   - Analyze FIR and IIR filters in time and frequency domains, their stability and performances.
   - Determine the spectrum of a digital signal using FFT with the suitable parameters (sampling frequency, window type, window length, FFT length)
   - Design FIR and IIR filters to meet specific magnitude and phase requirements.
   - Design and analyze digital filters, generate and process signals.
   - Create and analyze digital systems using Matlab and Simulink.

b. PI addressed by the course:

PI	1.1	1.2	1.3	6.1	6.2	6.3	6.4	
Covered	X	X	X	X	X	X	X	
Assessed			X	X	X	X	X	

7. Brief list of topics to be covered:

- Course introduction, signal and systems classification (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, sign 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 (2 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 (4 lectures)
- Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Windowing, spectrum analysis (3 lectures)
- Analyze Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters in time domain, in frequency domain using the Fourier transform, using the Z-transform and the representation of the zeros and poles in the Z-plan. Analyze Finite FIR filters with linear phase (5 lectures)
- Design FIR filters by widowing and design IIR filters using the impulse invariance technic and the bilinear transformation (4 lectures)
- Lab: Spectrum analysis, digital filtering (2x3 lab hours)