Module Code | EEU44C05
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Module Name | Digital Signal Processing
ECTS Weighting | 5 ECTS
Semester taught | Semester 1
Module Coordinator/s | William Dowling

**Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline**

On successful completion of this module, students should be able to:

1. Design FIR filters using the window and frequency sampling methods.
2. Design IIR filters to meet detailed gain specifications, via the bilinear transformation.
3. Design decimation and interpolation systems for discrete-time signals.
4. Design discrete-time systems to filter analogue signals.
5. Implement linear convolution of arbitrarily-long sequences via the FFT algorithm.
6. Characterise wide-sense stationary random signals and the outputs that result from LTI filtering of such signals.

**Graduate Attributes: levels of attainment**
- To act responsibly - Enhanced
- To think independently - Attained
- To develop continuously - Enhanced
- To communicate effectively - **Enhanced**

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1. *An Introduction to Module Design* from AISHE provides a great deal of information on designing and re-designing modules.
2. *TEP Glossary*
Module Content

Please provide a brief overview of the module of no more than 350 words written so that someone outside of your discipline will understand it.

Digital Signal Processing (DSP) is concerned with the processing of signals that are represented as sequences of finite-precision numbers. This course is an introduction to the theory and applications of digital signal processing. The DSP laboratory exercises are an integral part of the course and contribute to an enriched understanding of the theoretical material covered in the lectures.

- **Sampling and reconstruction of analogue signals**
  Review of continuous-time signal and system analysis using Fourier and Laplace transforms; Ideal impulse sampling and reconstruction of bandlimited signals; digital to analogue conversion, practical considerations

- **Discrete-time sequences**
  Discrete-time signals and systems, linearity, time-invariance, stability, causality; discrete-time convolution, linear constant-coefficient difference equations, magnitude and phase response; the discrete-time Fourier transform (DTFT) and its properties

- **The z-transform and its properties**
  The z-transform, region of convergence for the z-transform, inverse z-transform, z-transform properties

- **FIR filter design**
  Generalized linear-phase causal FIR filters; FIR linear-phase filter design using the window method; frequency-sampling design of FIR filters

- **IIR filter design**
  IIR filter design using the bilinear transformation; Filter design by impulse invariance

- **Realization of digital filters**
  Signal flow graph representation of linear constant-coefficient difference equations; basic network structures for implementing FIR and IIR digital filters

- **The Discrete Fourier Transform**
  The discrete Fourier transform (DFT); properties of the DFT; circular convolution; linear convolution via the DFT and the overlap-add method; the radix-2 decimation-in-time fast Fourier transform (FFT) algorithm

- **Changing the sampling rate using discrete-time processing**
  Sampling rate reduction by an integer factor; increasing the sampling rate by an integer factor; changing the sampling rate by a non-integer factor
• Discrete-Time Random Process

Mean and variance of a random variable; autocorrelation and autocovariance functions; cross-correlation and cross-covariance functions; wide-sense stationary random signal; ergodic process; power density spectrum; response of linear systems to random signals

Teaching and Learning Methods

The module is taught using a combination of lectures, tutorials and supporting laboratories.

3 lectures and 1 tutorial per week.
4 Matlab-based laboratories.

Assessment Details

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<tr>
<th>Assessment Component</th>
<th>Assessment Description</th>
<th>LO Addressed</th>
<th>% of total</th>
<th>Week due</th>
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<tr>
<td>Annual Examination</td>
<td>2-hour written examination</td>
<td>1-6</td>
<td>85</td>
<td>Exam week</td>
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<tr>
<td>In-class test</td>
<td>45-minute written test</td>
<td>1-4</td>
<td>15</td>
<td>8</td>
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Reassessment Requirements

The overall module mark at the Supplemental examinations will be determined solely on the basis of the written examination.

Contact Hours and Indicative Student Workload

Contact hours: 44

Independent Study (preparation for course and review of materials): 60

3 TEP Guidelines on Workload and Assessment
<table>
<thead>
<tr>
<th><strong>Recommended Reading List</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Pre-requisite</strong></td>
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<tr>
<td><strong>Module Co-requisite</strong></td>
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<td><strong>Module Website</strong></td>
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<td><strong>Are other Schools/Departments involved in the delivery of this module?</strong></td>
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<td><strong>If yes, please provide details.</strong></td>
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<td><strong>Module Approval Date</strong></td>
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