B31SC Digital Signal Processing

**COURSE DETAILS**

**Course Code:** B31SC  
**Full Course Title:** Digital Signal Processing  
**SCQF Level:** 11  
**SCAF Credits:** 15  
**Available as Elective:** No

**DELIVERY LEVEL**

Undergraduate: Yes  
Postgraduate Taught: Yes  
Postgraduate Research: Yes

**COURSE AIMS**

To provide students with the knowledge & skills to tackle significant signal processing tasks including their features, boundaries, terminology and conventions.  
Use a range of specialised DSP skills and techniques, which are at the forefront of DSP practise.  
To enable students to apply critical analysis, evaluation and synthesis to a range of DSP problems.  
To enable students to be apply a range of DSP techniques using DSP development tools.

**LEARNING OUTCOMES – SUBJECT MASTERY**

SM1p Knowledge and methodology of scientific principles underpinning the representation of digital signals (e.g., time domain, frequency domain), their properties (e.g., linearity, stability, causality and time-invariance), and processing is provided during lectures, tutorials and laboratory sessions. All topics are introduced with multiple examples and cross links between similar topics (e.g., the basic principle of probing a system with one family of signals or another leads to different transforms) are highlighted to enable students to maintain an overall view of the module. SM2p, SM3p Topics that are covered during the module include Fourier transforms (specifically, discrete and continuous time as well as Fourier series), algebraic manipulation, complex numbers, Z transforms and their link to the Laplace transform, convolution, and some basic proof techniques. All topics are delivered during lectures and their practical implementation during laboratory sessions. Basic algebraic manipulation involve solving in closed form the DTFT or the Z transform of time sequences involving variations of the geometric series. Basic proof techniques are required to show when a DSP system is linear, causal, time-invariant and stable. All these topics are assessed during the final examination with questions that require students to show their logical reasoning step by step. SM1fl Lectures, laboratory sessions, and tutorials provide a comprehensive understanding of the fundamental theoretical principles of digital signal processing SM2fl Evolution of DSP hardware is explored in laboratory sessions. SM3fl Critical evaluation and application of concepts is explored in laboratory sessions. EA1p Most of the focus is on mathematical modeling of digital signals and their processing via digital filtering. In particular, of all digital filtering models, students are exposed to linear and time-invariant ones, as their particularly simple form, i.e., via a convolution with an impulse function, allows a very concise representation. Students learn how to use these models to alter digital signals in a desired manner. This is delivered during lectures and during laboratory sessions with examples of basic signals (e.g., sinusoids) and basic digital processing (e.g., attenuation of sinusoids with a given period). EA2p Students learn how to determine if a system is linear, causal, time-invariant and stable. This allows them to decide whether the convolutional model applies as well as all the properties of its Fourier and Z transform. The LO is delivered during lectures, tutorials, and laboratory sessions and it is assessed in the final examination. EA3p Students are introduced to MATLAB programming during the laboratory sessions. Also they are introduced to the use of a DSP development system. EA2fl Fundamental mathematical techniques applied in digital signal processing. Assessed in coursework and exam. D1fl Understanding of dealing with underdetermined problems and
optimisation in the absence of useful information. Assessed in coursework and exam. D2fl Provision of basic DSP methodologies and their application in specific examples. Assessed in coursework and exam. ET2fl Commercial aspects of choice of DSP hardware and evolution of available options discussed in lab sessions. EP2p Students develop knowledge of MATLAB use and of using a DSP development environment (Code Composer Studio). EP3p Students develop laboratory skills by solving assignments during the laboratory sessions. This requires mastering the programming language, the theory and developing problem solving capabilities. EP2m Students develop knowledge of MATLAB use and of using a microcontroller development environment (MDK-ARM). EP3m Students develop laboratory skills by solving assignments during the laboratory sessions. This requires mastering the programming language, the theory and developing problem solving capabilities.

**LEARNING OUTCOMES – PERSONAL ABILITIES**

Use of DSP software development environment.
Ability to direct & take responsibility for own work.
Undertake critical evaluations of a wide range of experimental work

**SYLLABUS**

Review continuous- and discrete-time systems in time and frequency domains using Fourier analysis and as covered in B38SA and B39SB in short order.

Revision: continuous- and discrete-time systems in time and frequency domains using Fourier analysis (as covered in 838SA and 83988)
ii) Statistical properties of signals: probability density functions, cumulative distribution function, correlation, power spectrum density, moments

iii) Stochastic processes: wide-sense and strict-sense stationary, ergodic process;

iv) Fast Fourier transform (FFT), decimation in time and frequency, twiddle functions and butterflies (DIF & DIT), FFT processing rates; fast convolution;

v) Digital filters: FIR and IIR filters, lowpass, bandpass, and highpass transformations, finite precision effects, window functions, realisation of digital filters, adaptive filters, transformation of analog filter designs;

vi) Multirate signal processing, upsampling and downsampling, spectral properties

**COURSE RELATIONSHIPS**

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<th>Course Code</th>
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<th>Title</th>
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<th>Type</th>
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<td>B39SB</td>
<td>9</td>
<td>Time Frequency and Signal Analysis</td>
<td>School of Eng &amp; Physical Sci</td>
<td>Pre-Requisite</td>
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### LOCATION AND ASSESSMENT METHODS

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