Unit T8: Digital Signal Processing

Unit code:	R/503/7380
QCF level:	6
Credit value:	15

Aim

This unit aims to develop learners' understanding of engineering signal conversion and digital signal processing. It will also develop the skills needed to modify or update existing electronics or communication systems using digital signal processing techniques, and to design engineering applications that use digital signal processing (DSP) techniques.

Unit abstract

This unit introduces learners to the fundamentals of digital signal processing, which pervades a significant proportion of modern electronics engineering systems. The unit aims to develops the skills required for learners to make an appropriate choice of DSP platform from those available in order to modify or update existing electronics or communications systems. Learners will use computer simulation packages to gain experience in the implementation of real-time systems, especially in radio and mobile engineering communications. Through learning outcome 1 learners will develop an understanding of the underlying concepts and principles of digital signal processing through appropriate representation of sampled signals in their spectral form and their recovery through appropriate filtering. Learning outcome 2 covers the basic building blocks for developing real-time digital signal processing operations such as filtering, convolution and correlation. Through learning outcome 3 learners will consider a number of real engineering systems that use Digital Signal Processing (DSP) blocks and acquire the skills necessary to select appropriate DSP devices and platforms for specific applications. Finally, learning outcome 4 brings together the skills and understanding attained in the first three learning outcomes, requiring learners to design, analyse and test a number of DSP functions and their implementation to a full engineering system, using a computer simulation package such as MATLAB.

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Learning outcomes

On successful completion of this unit a learner will:

1 understand the conversion of engineering signals from one form to another

2 understand standard digital signal processing techniques

3 be able to develop models of digital signal processing used in industry

4 understand the use of computer simulation to design engineering applications of digital signal processing.

Unit content

1 Understand the conversion of engineering signals from one form to another

Data conversion: analogue and digital signals; sampling theorem; analogue to digital conversion (ADC); digital to analogue conversion (DAC); coding; quantisation; aliasing error; pre-filtering or anti-aliasing filtering

Spectra: Fourier transform (FT) representation of discrete timesignals; recovery of original analogue signal from its discrete form using appropriate filtering

2 Understand standard digital signal processing techniques

Digital filtering: building blocks for DSP operations; Z-transforms; inverse Z-transforms; implementation models of finite impulse response (FIR) filters; implementation models of infinite impulse response (IIR) filters; digital resonator

Signal processing: convolution; correlation

3 Be able to develop models of digital signal processing used in industry

Current applications: block diagrams to explain the embedded features of DSP in applications, eg mobile phones, radar, digital radio, digital cameras

DSP versus microprocessors: advantages of using dedicated DSP devices; architectures; operating systems; choice of DSPs; choice of DSP platforms to suit the application

4 Understand the use of computer simulation to design engineering applications of digital signal processing

Digital filter design: design of FIR digital filters; design of IIR digital filters

Adaptive filter: least mean square algorithm; gradient descent adaptation; noise cancellation; equalisation

Computer simulation: digital filters, eg FIR, IIR, adaptive

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Understand the conversion of engineering signals from one form to another	1.1 Explain the sampling principles and process 1.2 Describe the conversion of signals from analogue to digital form and vice versa 1.3 Critically examine the spectra of a discrete time signal 1.4 Explain the recovery of the original analogue signal from the discrete signal through appropriate filtering
LO2 Understand standard digital signal processing techniques	2.1 Explain the building blocks for digital signal processing operations 2.2 Justify the building block connections for digital signal processing systems 2.3 Critically evaluate the structure and performance characteristics of finite impulse response and infinite impulse response filters 2.4 Critically evaluate convolution and correlation functions for signal processing
LO3 Be able to develop models of digital signal processing used in industry	3.1 Model appropriate sections of digital signal processing blocks as part of an overall engineering system 3.2 Justify the choice of dedicated DSP devices when compared with normal microprocessors 3.3 Justify the selection of a digital signal processing device for a given application
LO4 Understand the use of computer simulation to design engineering applications of digital signal processing	4.1 Critically evaluate computer simulation of finite impulse response and infinite impulse response filters 4.2 Analyse convolution and correlation functions of noisy signals 4.3 Critically evaluate computer simulations of adaptive filters

Guidance

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes associated with this unit are closely linked with:

Level 5	Level 6
Unit 59: Advanced Mathematics for Engineers	*Unit T7: Modelling and Simulation for Engineers*
Unit 66: Electrical, Electronics and Digital Principles	*Unit T12: Digital Communications*

The content of this unit has been designed and mapped against the Engineering Council's current Learning Outcomes for IEng Accreditation. The completion of the learning outcomes for this unit will contribute knowledge, understanding and skills towards the evidence requirements for IEng Registration.

See *Annexe B* for summary of mapping information for IEng Accreditation.

Essential requirements

Suitable simulation software packages such as MATLAB are required for the assignment/project work.

Resources

Books

Tan L – *Digital Signal Processing: Fundamentals and Applications* (Elsevier, 2008) ISBN 978-0123740908

Ifeachor E C and Jervis B W – *Digital Signal Processing: A Practical Approach*, 2nd edition (Prentice Hall, 2002) ISBN 978-0201596199

Diniz P S R, daSilva E A B and Netto S L – *Digital Signal Processing: System Analysis and Design* (Cambridge University Press, 2010) ISBN 978-0521887755