**CMP4101 Digital Signal Processing**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Period per  Week | | | Contact  Hour per  Semester | Weighted  Total Mark | Weighted  Exam Mark | Weighted  Continuous Assessment Mark | Credit  Units |
| LH | PH | TH | CH | WTM | WE | WCM | CU |
| 45 | 30 | 00 | 60 | 100 | 60 | 40 | 4 |

**Rationale**

Computer Engineering benefits from Digital signal processing, through its application in the transformation, synthesis and analysis of data. For example, when modelling a communication channel, filters, generators and analyzers can be used to remove, add or measure noise in processing audio, images and video. The computer engineer to-be therefore has to have a thorough introduction to Digital signal processing.

**Course Content**

***1. History and Overview***

 Indicate some reasons for studying digital signal processing and multimedia

 Highlight some people that influenced or contributed to the area of digital signal processing and multimedia

 Indicate some important topic areas such as digital audio, multimedia, wave tables, digital filters, image display, chromatic and achromatic lighting, and thresholds

 Contrast the meanings of analog and digital signals

 Explain the need for using transforms and why they are different for analog and discrete situations

 Indicate how the subject relates to simple graphics

 Contrast image processing from computer graphics

 Mention some techniques used in transformations such as Fourier, Laplace, and wavelet transforms

 Explore some additional resources associated with digital signal processing and multimedia

 Explain the purpose and role of digital signal processing and multimedia in computer engineering

***2. Theories and concepts***

 The sampling theorem

 Nyquist frequency

 Aliasing

 Relationship between time and frequency domain

 Principle of causality such as discrete and continuous spectra

***3. Discrete Fourier transform***

 Definition of the Discrete Fourier Transform (DFT)

 Relationship between original and transformed domains

 Algorithms of the DFT

 Linear convolutions

 Contrast DFT with the Fourier Transform and the Fast Fourier Transform

(FFT)

 Filtering using DFT

 Filtering of long data sequences

***4. Digital spectra analysis***

 Spectral views

 Spectrum analysis

 Spectra of periodic signals

 Spectra of the impulse and a square wave

 Filtering

 Interpolation

***5. Sampling***

 Implications of assumptions of repeated time series

 Group sampling of time signals

 Size of group and how it affects spectra

 Sampled signals

 Periodic signals

 Non-periodic signals

 Spectrograms

***6. Transforms***

 Concept and properties of the z–transform

 Inverse z–transforms

 Difference equations

 The Discrete Fourier Transform

 The Inverse DFT

 The Fast Fourier Transform Class

 The Inverse FFT method

 Fast Convolution using the FFT

 Power Spectral Density

 Frequency shifting using the FFT

 Filtering using FFT

 Additive and subtractive synthesis

***7. Digital filters***

 Frequency response of discrete – time systems

 Recursive filter design

 Nonrecursive filter design

 Windowing

 FIR filters, frequency and phase response, time domain multi-tap filters, surface acoustic wave filters

 Poles and zeros in the z plane

 IIR filters, frequency and phase response

 Design of IIR Filters

***8. Discrete time signals***

 Representation of signals

 Sampling of signals

 Quantizing

 Aliasing

 Difference Equations

***9. Window functions***

 Definition of a window function

 Purpose of a window function

 Signal compression and transform properties

 Window functions and their impact on the spectra

 Window functions and the DFT

***10. Convolution***

 Impulse response

 Convolution integral

 Physically realizable systems

 Graphical methods

**Learning Outcomes**

 Identify some contributors to digital signal processing and multimedia and relate their achievements to the knowledge area.

 Know the difference between analog and discrete signals.

 Describe how computer engineering uses or benefits from digital signal processing and multimedia.

 Explain the purpose of a Fourier transform in signal processing.

 Describe the advantage of the FFT.

 Contrast how group size affects signal spectra.

 Understand the concept, properties and uses of the z–transform.

 Understand the relationship between z–transform and the conformal map

 Understand the Discrete Fourier transform and its significance.

 Understand frequency selective filters in the z–transform domain.

 Understand the definition of a window function.

 Understand the discrete-time representation of signals.

 Use the convolution technique to analyze circuits.

**Recommended and Reference Books**

*[1]* Emmanuel C. Ifeachor, Barrie W. Jervis, *Digital Signal Processing; A practical*

*Approach*, 2nd Edition, Prentice Hall, 2002.

*[2]* Richard G. Lyons, *Understanding Digital Signal Processing,* 2nd Edition, Pearson

Education, 2004.

*[3]* John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing; Principles, Algorithms and Applications,* 4th ed., Prentice Hall, 2006.

*[4]* S. Salivahanan, A. Vallararaj, C. Gnanapriya, *Digital Signal Processing,* Tata

McGraw-Hill Publishing Company Limited, 2006.

*[5]* A.V. Oppenheim and R.W. Schafer, *Digital Signal Processing,* Prentice Hall, Englewood Cliffs NJ, 1975.

*[6]* Sanjit K. Mitra, *Digital Signal Processing,* 3rd ed., 2006

*[7]* Boaz Porat, *A course in digital signal processing,* John Wiley & Sons Inc., 1997.

*[8]* Alan V. Oppenheim, Ronald W. Schafer, *Discrete-time Signal Processing,* Prentice- Hall, International ed., 1989.

*[9]* Lawrence R. Rabiner, Bernard Gold, *Theory and application of digital signal processing,* Prentice-Hall Inc., 1975.