Course Code : **CC 741**

Course Title : **System Science and Engineering**

Credit Hours : **3**

Course Description

Introduction to Systems engineering Systems engineering principles, Reliability engineering, failure modes and effects analysis, The systems engineering process, Using models, Tools for graphic representations, Performance engineering, Systems analysis, probability analysis, design methods and dynamic systems, System stability, estimation, optimization, modeling, identification, and simulation, Signal Processing and Complex Systems Developments of nonlinear signal and information processing methods from a generic systems engineering perspective, Digital and analogue signals z-transform Hilbert transform, Fourier Analysis, Limitations and relations to other Fourier techniques. The concept of windowing and its implications in the different application contexts of spectrum estimation and discrete-time filter design. Rate changing processes of decimation and interpolation in discrete time systems,Introduction to Wavelet transform. The continuous and discrete wavelet transforms and their roles in signal processing applications. Multi-rate signal processing systems. The concepts behind joint time-frequency representations. Simple multi-resolution analysis of signals using the Haar basis, Discrete-Time Bases and Filter Banks. Analysis and design of filter banks, Orthogonal and biorthogonal filter banks, Tree-structured filter banks, Discrete wavelet transform, Wavelet families, Wavelet series and its properties, Regularity and approximation properties, Multidimensional filter banks and wavelets. Multi scale geometric representation and processing. Compressed sensing, 2D and 3D signal analysis, Speech, audio, image, and video compression, Signal de-noising, Feature extraction, and Inverse problems.

Course Objectives

The course educates students in the engineering and science of systems. Graduates are expected to have mathematical competence and knowledge of systems analysis, and design methods, probability analysis, dynamic systems, system reliability, estimation, modeling, identification, and simulation. Elaborate developments of nonlinear signal and information processing methods from a generic systems engineering perspective.

The use of Wavelets to analyze data that changes over time or has hidden “events” that would not show up on an FFT. Understand and efficiently use the types of Wavelet Transforms to better analyze and process data. State-of-the-art methods and applications. The course will handle the compression and de-noising of data using advanced Wavelet techniques and how to avoid potential pitfalls by understanding the concepts. How to increase productivity and reduce cost by choosing (or building) a Wavelet that best matches your particular application.

Course Topics

Week no. 1:	Introduction to Systems engineering Systems engineering principles.
Week no. 2:	Reliability engineering, failure modes and effects analysis.
Week no. 3:	The systems engineering process, Using models, Tools for graphic representations
Week no. 4:	Performance engineering

Week no. 5: Systems analysis, probability analysis, design methods and dynamic systems.

Week no. 6: System stability, estimation, optimization, modeling, identification, and simulation

Week no. 7: Signal Processing and Complex Systems Developments of nonlinear signal and information processing methods from a generic systems engineering perspective / 7th week evaluation.

Week no. 8: Digital and analogue signals z-transform Hilbert transform

Week no. 9: Fourier Analysis, Limitations and relations to other Fourier techniques. The concept of windowing and its implications in the different application contexts of spectrum estimation and discrete-time filter design. Rate changing processes of decimation and interpolation in discrete time systems

Week no. 10: Introduction to Wavelet transform. The continuous and discrete wavelet transforms and their roles in signal processing applications. Multi-rate signal processing systems. The concepts behind joint time-frequency representations. Simple multi-resolution analysis of signals using the Haar basis.

Week no. 11: Discrete-Time Bases and Filter Banks. Analysis and design of filter banks, Orthogonal and biorthogonal filter banks, Tree-structured filter banks, Discrete wavelet transform.

Week no. 12: Wavelet families. Wavelet series and its properties. Regularity and approximation properties / 12th week evaluation.

Week no. 13: Multidimensional filter banks and wavelets. Multi scale geometric representation and processing. Compressed sensing.

Week no. 14: 2D and 3D signal analysis, Speech, audio, image, and video compression.

Week no. 15: Signal de-noising, Feature extraction, and Inverse problems

Week no. 16: Presentation of projects and Final Exam.