# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

## COURSE CONTENT

| WAVELETS AND APPLICATIONS | | | | | | | | |
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| **VI Semester: ECE** | | | | | | | | |
| **Course Code** | **Category** | **Hours / Week** | | | **Credits** | **Maximum Marks** | | |
| | | **L** | **T** | **P** | **C** | **CIA** | **SEE** | **Total** |
| **AECD39** | **Elective** | 3 | - | - | 3 | 40 | 60 | 100 |
| **Contact Classes: 48** | **Tutorial Classes: Nil** | **Practical Classes: Nil** | | | | **Total Classes: 48** | | |
| **Prerequisite: Signals and Stochastic Process** | | | | | | | | |

### I. COURSE OVERVIEW:

The aim of this course is to enhance understanding of fundamental knowledge Wavelets provide a powerful tool for signal analysis and data processing, particularly in scenarios where traditional Fourier analysis is less effective due to its inability to capture localized information. Their ability to analyze data in both time and frequency domains make them versatile and widely applicable in various fields.

### II. COURSES OBJECTIVES:

**The students will try to learn**

I. Introduce the algorithms and basic theory of wavelets and framelets to students and interested researchers.
II. Bring the students and researchers to the wide scope of applications using wavelets and framelets.
III. Present some most recent developments on wavelets and framelets.
IV. Apply wavelets, filter banks, solution techniques to a problem at hand, and justify why wavelets provide the right tool.
V. Think critically, ask questions, and apply problem-solving techniques

### III. COURSE OUTCOMES:

**At the end of the course students should be able to:**

CO1 Explain the concepts, theory, and algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multire solution analysis (computer vision).
CO2 Differentiate continuous wavelet and discrete wavelet transforms and analyze multi-resolution analysis.
CO3 Develop bi-orthogonal wavelet basis function and apply to two dimensional signals
CO4 Apply wavelet transform for image and audio compression
CO5 Describe scaling functions, continuous wavelet transforms and different wavelet Functions.
CO6 Employ wavelet transforms for de-noising, speckle removal, object detection and data communication

## IV. COURSE CONTENT:

**MODULE - I: WAVELETS (10)**
Introduction: Continuous wavelet transforms, Properties, Inverse transform, Examples of mother wavelets, Analytic wavelet transform. Self-Study: Implementation of mother wavelets using Mat software.

**MODULE –II: DISCRETE WAVELET TRANSFORM (09)**
Introduction to Discrete Wavelet Transform: MRA, A wavelet basis for MRA, Digital filtering interpretation, Examples of orthogonal basis –generating wavelets, interpreting orthonormal MRAs for discrete time signals. Self-Study: Implementation of feature extraction

**MODULE –III: BI-ORTHOGONAL WAVELETS (10)**
Bi-orthogonal Wavelets: Bi-orthogonal wavelet bases, Filtering relationship for bi-orthogonal filters, Examples of bi-orthogonal scaling functions and wavelets, two dimensional wavelets, Multidimensional wavelets and wavelet packets. Self-Study: Implementation of classification of data using wavelets.

**MODULE –IV: WAVELET TRANSFORM AND DATA COMPRESSION (10)**
Wavelet transform and data compression: Transform coding, DTWT for image compression, Audio compression and video coding. Self-Study: Implementation of Image compression using wavelet transforms.

**MODULE –V: NANOTECHNOLOGY (09)**
Applications of Wavelet Transforms: De-noising, Biomedical applications, Applications in communication system, Edge detection and object isolation, Image fusion. Self-Study: Application of wavelets in bio-medical signals

## V. TEXT BOOKS:

1. Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: Introduction to Theory & Applications", Pearson Education Asia, New Delhi, 2003
2. Agostino Abbate, Casimer M. DeCusatis and Pankaj K. Das, "Wavelets and Subbands Fundamentals and Applications", Pearson Education Asia, New Delhi, 2008

## VI. REFERENCE BOOKS:

1. K. P. Soman and K.L. Ramchandran, "Insight into Wavelets from theory to practice", Eastern Economy Edition, 2008
2. Stephane G. Mallat, "A Wavelet Tour of Signal Processing", Academic Press, Second Edition, 1999.
3. K. P. Soman, K. I. Rmachandran, N. G. Resmi, "Insight into Wavelets: From Theory to Practice, (Third Edition)", PHI Learning Pvt. Ltd., 2010.
4. C. S. Burrus, Ramose and A. Gopinath, Introduction to Wavelets and Wavelet Transform, Prentice Hall Inc.

## VII. ELECTRONICS RESOURCES:

1. http://www.wavelet.org/
2. http://www.math.hawaii.edu/~dave/Web/Amara's%20Wavelet%20Page.htm

## VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper - I
7. Model question paper - II
8. Lecture notes
9. Early learning readiness videos (ELRV)
10. Power point presentations