TIME-FREQUENCY ANALYSIS AND ITS APPLICATION
(Elective Subject)

Course Code:	**17B1WEC731**	**Semester:**	**7th Semester, B. Tech (ECE)**
Credits:	**3**	**Contact Hours:**	**L-3, T-0,P-0**

Pre-requisites: Signal & System, Digital Signal Processing

Course Objectives:

The objective of this course to provide the understanding of basics concept and MATLAB based implementation of time-frequency analysis (TFA) tools for various applications.

Course Outcomes

After the study of this course students will be able to:

1. Understand the spectral analysis of the signals.
2. Understand the basics concept of the short time Fourier transform.
3. Familiar with the basics concept of the discrete wavelet transform /continuous wavelet transform.
4. Understand the basic concept of the distribution based Time-Frequency Analysis tools
5. Develop the TFA based algorithms for various applications.

Course Contents :

Unit	Topics	Text book	Lectures
1	**Introduction to spectral analysis:** Parametric and Non-Parametric methods	[1]	**08**
2	**Basic Concepts & Definition of time-frequency tools:** Bandwidth Equation, uncertainty concept, Instantaneous Frequency, Analytic Signals, Multicomponent Signals etc.	[2]	**04**
3	**Short Time Fourier Transform:** Conditions for valid windows, Time domain and frequency domain formulations, Duality in the interpretations, MATLAB based implementation of STFT	[2] & [6]	**04**
4	**Wavelet transforms:** Introduction and basic concept of continuous and discrete wavelet transform, MATLAB based implementation of wavelet transform.	[3] &[6]	**04**
5	**Distributions based time-frequency tools:** Introduction and basic concept Wigner-Ville distribution & Cohen's class of distribution etc. MATLAB based implementation of distribution based time-frequency analysis tools.	[2] &[4]	**06**
6.	**Case studies:** Joint Time-Frequency Transform/ Inverse Synthetic Aperture Radar, Joint Time-Frequency Representations/Time-Varying Signals, Economic Data Analysis with the Gabor Spectgrogram, Gabor Spectrogram in Ultrasonic Nondestructive Materials Evaluation, Applications of Time-Frequency Signal Processing in Wireless Communications and Bioengineering	[2], [3], [4] & [5]	**16**
	Total Hours		**42**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    1. 10 Marks : Class performance, Tutorials & Assignments
    2. 10 Marks : Quizzes
    3. 5 marks : Attendance

Text Books

1. Hayes, M.H.,"Statistical digital signal processing and modeling" Willey publishers
2. Boualem Boashash, Time-Frequency Signal Analysis and Processing: A Comprehensive Reference, Elsevier publishers, 2003
3. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
4. L. Cohen, Time-Frequency Analysis. Prentice Hall, 1995.
5. Hao Ling and Victor C. Chen, Time-frequency Transforms for Radar Imaging and Signal Analysis, Artech House Publishers, 2000
6. http://nptel.ac.in/courses/117101001/: The lecture series on Wavelets and Multirate Digital Signal Processing created by Prof. Vikram M. Gadre in NPTEL.

REFERENCE BOOKS

1. Stanskovic L., Dakovic, M., Thayparan, T., Time-Frequency Signal Analysis and Processing: A Comprehensive Reference, Artech House Publishers.
2. Karlheinz Gröchenig, Foundations of Time-Frequency Analysis, Birkhäuser publishers, 2001
3. M. Vetterli, J. Kovacevic, and V. K. Goyal, Fourier and Wavelet Signal rocessing. Booksite: **http://fourierandwavelets.org/terms.php**

OTHER RESOURCES

Time-frequency toolbox (MATLAB) is available for download from **http://tftb.nongnu.org/**

http://nptel.ac.in/courses/117101001/1