

# Empirical Mode Decomposition and its Applications

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## Overview

The objective of this course is to introduce modern methods of analyzing real-world signals to researchers interested in understanding the pure science behind natural signals, or its various engineering applications. As most people are aware, Fourier Transform has remained the most influential technique for signal processing and analysis. Even though Fourier Transform is **not suited** for analyzing signals which are produced by non-linear and non-stationary processes, i.e., real-world or natural signals, most researchers are almost addicted to it. People working in engineering applications, especially, focus more on the machine-learning aspects, leaving the science behind. At best, engineers and even scientists use stop-gap arrangements like the Short-Term Fourier Transform (STFT). Researchers working in the field of **non-linear and non-stationary signal processing**, however, have been exploring ways and means of extracting the “**true constituents**” of any natural signal. Methods like Wigner-Ville Transform, Wavelet Transform, and Evolutionary Algorithms are a result of their efforts. “**How to find out the frequency content at every sample point (usually denotes time) of the signal, i.e., how to perform Time-Frequency Analysis (TFA) of the signal ?**”. The task is difficult, but the benefits are extraordinary. If successful, the various mechanisms that produce the signal would be revealed. For engineers working in various applications, this provides a way for better and robust feature extraction, throwing away the shackles of linearity and stationarity. Completely new and efficient methods for different applications could result from such an analysis.

This course is dedicated to understanding a modern technique called **Empirical Mode Decomposition (EMD)**, and its applicability to analyzing real-world natural signals. EMD was conceived in 1998 by Huang et al., for which Dr. Norden Huang, the chief architect of this method, was awarded **NASA’s Special Space Act Awards** in 1998, 2003 and 2004. The ability of EMD to decompose real-world signals into their true and meaningful components has been widely appreciated in the various fields of science and engineering. Some of the prominent disciplines where EMD is being actively explored are :

- Climate, Weather, Meteorological and Solar radiation sciences
- BioEngineering and Molecular Sciences
- Geology, Geophysics, Metallurgical, Oceanology and water sciences
- Mechanical Signal Processing
- Speech and Audio Processing

The course would be primarily delivered by **Prof. Patrick Flandrin, who is an imminent physicist from France, working in the field of TFA, holding around 20,000 citations for his works**. We welcome all interested to attend the course.

## Objectives

- Introduction to the fundamentals of TFA.
- Exposure to EMD, and its advanced versions.
- Exposure to applications of EMD, and identification of research directions in EMD and EMD-like methods.

## Benefits

- Exposure to new signal processing methods.
- First hand experience and interaction with leading expert in the field.
- Explanations of examples of real-world signal natural signal analysis.
- Hands-on MATLAB sessions.

## Course Details

**Dates : 23 October 2017 – 27 October 2017**

### Day 1:

Lecture 1: 9:00 to 10:00 AM  
Lecture 2: 10:30 to 11:30 AM  
Laboratory 1: 2.00 to 5.00 PM

**Introduction (Beyond Fourier)**  
**EMD principle**  
**MATLAB exercises on EMD and HHT**

### Day 2:

Lecture 3: 9:00 to 10:00 AM  
Lecture 4: 10:30 to 11:30 AM  
Laboratory 2: 2.00 to 5.00 PM

**EMD specificities**  
**EMD for Speech Processing Part 1**  
**MATLAB exercises on Speech Processing using EMD**

### Day 3:

Lecture 5: 9:00 to 10:00 AM  
Lecture 6: 10:30 to 11:30 AM  
Laboratory 3: 2.00 to 5.00 PM

**EMD variations 1**  
**EMD for Speech Processing Part 2**  
**MATLAB exercises on EMD based denoising and detrending**

### Day 4:

Lecture 7: 9:00 to 10:00 AM  
Lecture 8: 10:30 to 11:30 AM  
Laboratory 4: 2.00 to 5.00 PM

**EMD variations 2**  
**EMD versus TFA**  
**MATLAB exercises on Biosignal processing using EMD**

### Day 5:

Lecture 9: 9:00 to 10:00 AM  
Lecture 10: 10:30 to 11:30 AM  
Examination 1: 2.00 to 5.00 PM

**EMD for Biosignal processing**  
**Challenges and opportunities in EMD and EMD-like techniques**  
**Course examination**

## Who can Attend ?

- Graduate and Post-graduate students at all levels (B.Tech/B.E./M.Tech/M.E./M.Sc./Ph.D) who are interested in Signal Processing and its applications to different fields of engineering.
- Faculty and/or project staff from academic and technical institutions, and researchers in R&D organizations, interested in and/or working in the field of Signal Processing, and its modern methods.

## Fees

### Accommodation Fooding

Students : **INR 1000** /- (Refundable)  
Participants from abroad : **USD 500** /-  
Industry/ Research Organizations: **INR 20,000** /-  
Academic Institutions: **INR 10,000** /-

The fees is to be paid using **Demand Draft**. The Demand Draft for the students (only) will be returned back to them if and when they physically attend the course.

<b>Course Co-ordinators</b>	<p><b>Department of Electronics and Electrical Engineering, IIT Guwahati, Guwahati – 781039, India</b></p> <p><b>Prof. S. R. Mahadeva Prasanna - <a href="mailto:prasanna@iitg.ernet.in">prasanna@iitg.ernet.in</a></b> Tel: +919954008138</p> <p><b>Prof. Rohit. Sinha - <a href="mailto:r.sinha@iitg.ernet.in">r.sinha@iitg.ernet.in</a></b> Tel: +91-361-258-2506</p>
<b>Registration Procedure</b>	<p><b>Please follow the following steps for registration :</b></p> <ol style="list-style-type: none"><li>1. Go to GIAN website (<a href="http://www.gian.iitkgp.ac.in/GREGN/index">http://www.gian.iitkgp.ac.in/GREGN/index</a>) First time users need to register and pay a one-time fee of <b>INR 500 /-</b>.</li><li>2. Select course : <b>Empirical Mode Decomposition and its Applications</b>. Once you enroll for the course, an <b>Enrollment/Application</b> number will be generated, and the course coordinators will be notified. The course coordinators will <b>shortlist</b> the candidates out of the applicants. The shortlisted candidates <b>will be notified by email</b>.</li><li>3. The <b>selected</b> candidates must pay the applicable fees using <b>Demand Draft (DD)</b> drawn in favour of <b>“Registrar, INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI”</b>.  Please write your Name and Enrollment/Application number at the back of the DD, and <b>post/courier</b> it, to reach <b>by 15 October 2017 23:59 hrs IST</b>.</li></ol> <p><b>Address :</b></p> <p style="text-align: center;">Department of Electronics and Electrical Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam, India, PIN - 781 039, Email: <a href="mailto:eeeoff@iitg.ernet.in">eeeoff@iitg.ernet.in</a> Telephone: +91-361-2582550 Fax: +91-361-2582542 +91-361-2690762</p> <ol style="list-style-type: none"><li>4. Fill the <b>course registration form</b> in GIAN portal. Email the <b>course registration form</b> to the Course Co-ordinators <b>by 15 october 2017 23:59 hrs IST</b>.</li></ol>

## The Faculty



### **Prof. Patrick Flandrin**

[http://perso.ens-lyon.fr/patrick.flandrin/essai\\_entree2\\_eng.html](http://perso.ens-lyon.fr/patrick.flandrin/essai_entree2_eng.html) is an eminent researcher in the field of non-stationary signal processing, having published works with ~ 20,000 citations. He is a member of the Signal Processing Department of ICPI Lyon (now CPE Lyon). He is also *Associate Director of* the federative CNRS structure, information, Signal, Images et Vision (ISIS). He was awarded the Philip Morris Scientific Prize in 1991, SPIE “Wavelet Pioneer Award” and Michel Monpetit prize from the French academy of sciences in 2001. In 2014 he was honored as “Knight of the National order of the academic palms”.



### **Prof. S. R. M. Prasanna**

<https://www.iitg.ernet.in/eee/emstlab/profiles/srmp.php> is currently a Professor in the Department of Electronics and Electrical Engineering (EEE) at IIT Guwahati. He has supervised many PhD Theses on different issues related to speech signal processing. He has cofounded Speechwarenet and DFM InfoAnalytics companies working on the development of speech and multimedia products. His research interests include speech processing, handwriting processing and audio processing.



### **Prof. S. Dandapat**

<https://www.iitg.ernet.in/eee/emstlab/profiles/sd.php> joined the Department of Electronics and Electrical Engineering (EEE) of IIT Guwahati in 1997 and became Professor in 2007. His teaching and research interests include signal processing, particularly in the fields of biomedical signal processing, and speech processing. He has supervised many PhD Theses in these areas and published in reputed national and international journals and conferences.



### **Prof. R. Sinha**

<https://www.iitg.ernet.in/eee/emstlab/profiles/rsinha.php> joined the Department of Electronics and Electrical Engineering (EEE) of IIT Guwahati in 2006 and became Professor in 2015. His teaching and research interests include signal processing, particularly in the fields of speech and image processing. He has supervised many PhD Theses in these areas and published in reputed national and international journals and conferences.