#### Tutorial 4: Vibration-based condition monitoring of a gearbox

Download the Data : ‘**Gear\_vib.mat’**

The aim of this project is to understand the vibrations generated by a real-life gearbox and design a vibration-based strategy for condition monitoring. Hereafter, real-word data measured from an actual gearbox will be shared with the students. Raw signals are measured at high definition on a test bench with an accelerometer mounted in the vicinity of gearbox. One signal is acquired per day, for 12 days, at a sampling frequency of 20 kHz. The gear 1 and gear 2 have respectively teeth and teeth. is around 330 Hz. The target phenomenon is to identify a progressive local fault in gear 1. Note that the gear mesh frequency can vary between 330 Hz and 346 Hz. This gap is due to the variation of speed of test bench. The exact values of the meshing frequencies are given hereafter :

* + Day 1 :
  + Day 2 : 340 Hz
  + Day 3 : 330,58 Hz
  + Day 4 : 334,83 Hz
  + Day 5 : 338 Hz
  + Day 6 : 338,33 Hz
  + Day 7 : 337,5 Hz
  + Day 8 : 338 Hz
  + Day 9 : 345,44 Hz
  + Day 10 : 345,66 Hz
  + Day 11 : 334,42 Hz
  + Day 12 : 335,25 Hz
* The frequencies et of gear 1 and gear 2 can be deduced by simply using the following formulapourront être déduit pour chaque cas en utilisant la formule :

**Task 1 : Time-domain analysis**

1. For each of these signals, sketch the vibration signal with respect to time (For practical reasons, use three figures with four subplots each. You will obtain 3 figures and each figure will comprise 4 subplots.
2. Describe how the amplitude and the shape of these signals change with the records.
   * *Bonus: Compute the indicators used in tutorial 1 to monitor the degradation of the gear.*
3. Compute the approximate period and (in second) of gear 1 and gear 2 (considering GMF=330Hz)
   * *Hint:* *Compute first the rotating frequencies and using the number of teeth and* .
4. Sketch the signals in a) over three periods of the first gear (i.e. from to ). Comment the result.
5. From what you see, in which day the fault start to appear?
6. How the mechanical defects manifest in the vibration signal?

**Task 2 : Frequency domain analysis**

1. Compute the (amplitude) spectra of the vibration signals and sketch them in the same manner as in the previous exercise. How is the shape of these spectra change with the progression of the fault.
2. Display the same spectra in Decibel. In which case the progression of the defect is perceived better ? What is the usefulness of such a presentation in practice ?
3. Perform a zoom around the meshing frequency (between GMF-100Hz and GMF+100Hz for example) for all the spectra. How the frequency content around the meshing frequency is changing ?
4. Repeat (c) for the second meshing frequency (between 2\*GMF-100Hz and 2\*GMF+100Hz for example)