# Supervision systems course

Chapter 6: Modulation and Beats

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# Outline

# Introduction

In Chapter 6, we delve into a comprehensive exploration of signals, modulation, and beats. Building upon our previous classes, where we focused on signal analysis, particularly in the time domain and frequency domain, this chapter expands our understanding of these concepts. We will delve into the intricacies of signal properties, modulation techniques, and the phenomenon of beats, aiming to provide a thorough foundation for further exploration in this field.

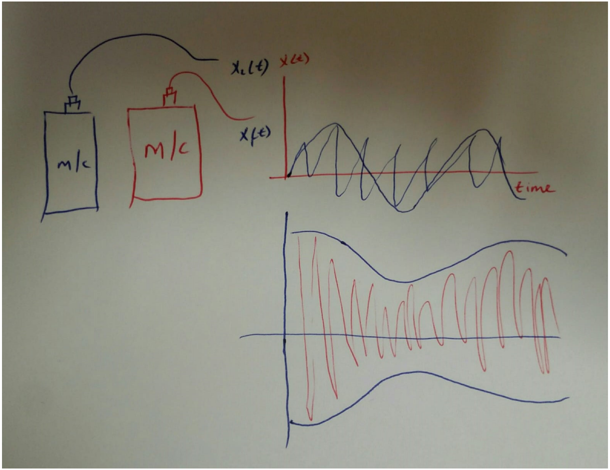
# Introduction

### What is a modulation?

Modulation is a dynamic process that involves the deliberate alteration of one or more characteristics of a periodic waveform, known as the carrier signal. This modification is achieved by introducing another distinct signal referred to as the modulation signal. The modulation signal typically encapsulates specific information intended for transmission. In essence, modulation serves as a crucial technique for embedding data onto a carrier signal, facilitating effective communication in various applications.

# Two independent machine source

The received signal from machine 1 will affect that one from machine 2



# Two independent machine source

For two independent machine source, if we have two independent signal $f_0$ and $f_0 + \delta f$ as shown below:

$$y = A\sin(2\pi f_o t) + A\sin[2\pi(f_o + \Delta f)t]$$
$$= 2A\cos(2\pi \frac{\Delta f}{2} t)\sin(2\pi \frac{f_o + f_1}{2} t)$$

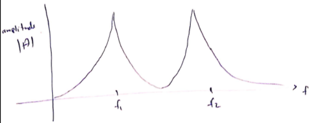
# Beat Frequency and Heterodyning

Beat Frequency and Heterodyning:-

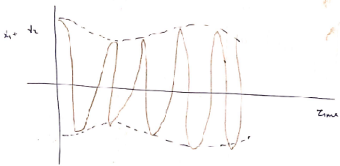
From the previous equation we have two frequencies $f_1 = f_0$ and $f_2 = f_0 + \Delta f$. Those two-independent signals are not interacting; But if you bring those two-signals clo to each others where $\Delta f$ is very small quantity

$\approx \Delta f \leq$ small quantity

then the marginal difference $f_2 - f_1 = \Delta f$ very small.



# Beat Frequency and Heterodyning




then we have amplitude max and amplitude min ($A_{max}$, $A_{min}$)

⇒ this happen when they are near to each other.

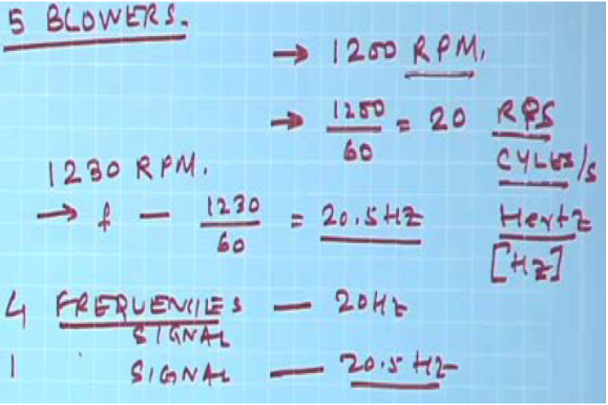
⇒ When the frequency of 2. signal ($f_1$, $f_2$) are close to each other ⇒ give what is known as Phenomena of Beating


Beating frequency is the difference between these 2 frequencies

→ signal
① independent
② close to each other in frequency.

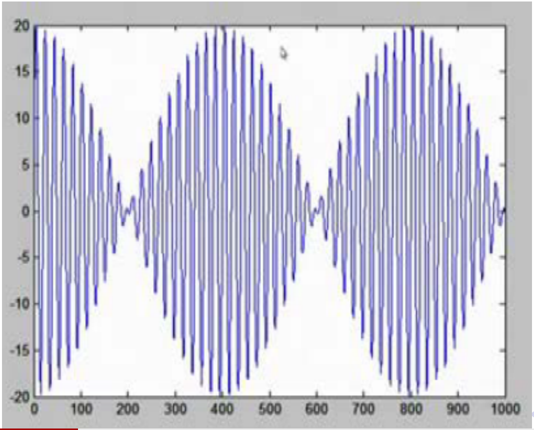
# Example on Beating

I have 4 frequencies from 4 blowers running at 1200 rpm at 20 hertz and one blower at 20.5 hertz.



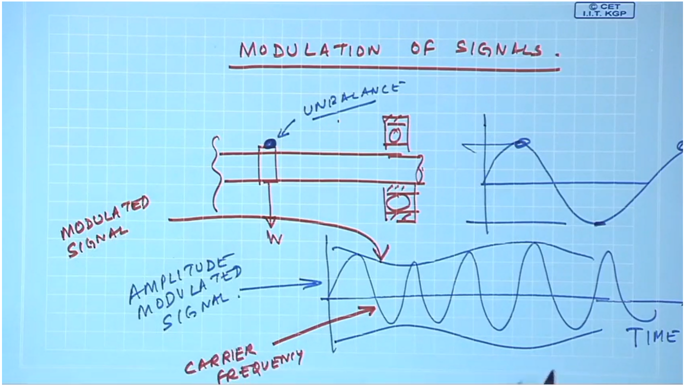
# Example on Beating

Wave Frequencies 10 Hz and 10.5 Hz (The following fig. shows sin wave of 10 hertz and another one very close by with 10.5 hertz, if you sum them up, the composite waveform looks like this fig. that means, the amplitude is increasing decreasing)



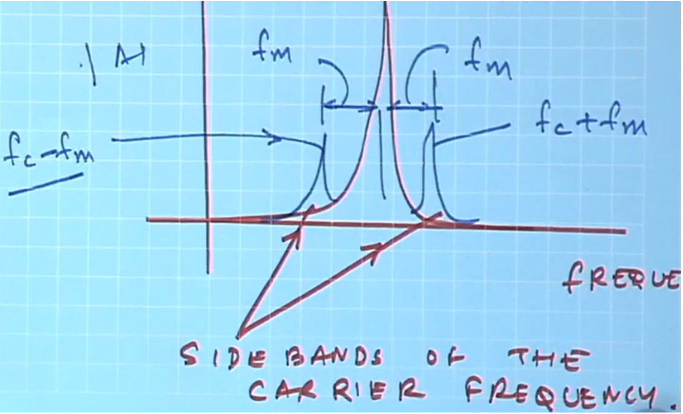
# Modulation

The two Frequencies are predominant here the carrier frequency and the modulated signal.



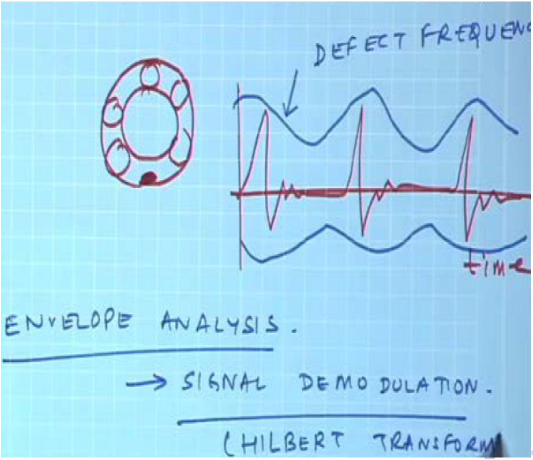
# Modulation

The amplitude modulation occurred because there is a load variation, e.g. bearing signal which has been loaded on a shaft where there is a strong amount of unbalance.



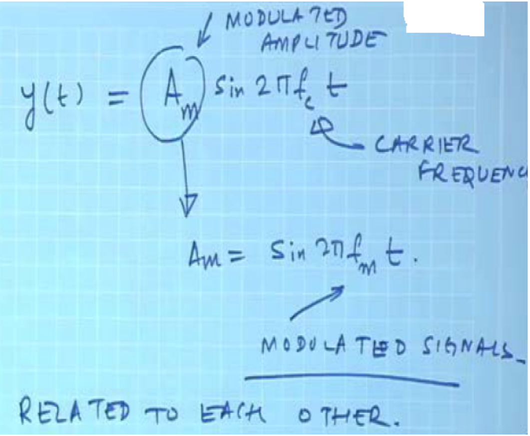
# Modulation

If there is a defect here in Bearing and every time, every revolution this defect would give rise to a pulse and this could be amplitude amplified during load.



# Modulation

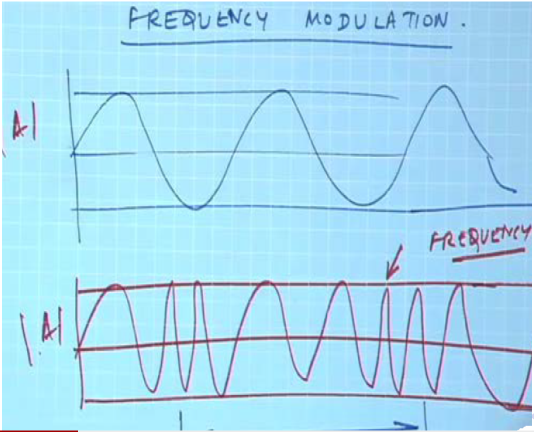
# Modulation




The signals are related to each other, one is creating other; unlike beats where they are independent.

# Modulation

Frequency Modulation (FM) is the encoding of information in a carrier wave by changing the instantaneous frequency of the wave. FM technology is widely used in the fields of computing, telecommunications, and signal processing.



# Modulation

Pulse Code Modulation (PCM); Self study!!!

# Thank You!