**Abstract :**

In this experiment we are going to learn about angle modulation in which it consists basically from two parts , FM modulation and PM modulation . It aims to introduce students of the Characteristics of the FM modulator , how the message signal is modulated , where it is carried , how to represent the modulated signal in time domain and Frequency domain , How to analyze the spectrum of the FM modulated signal and to determine and understand the zero crossing for the carrier in frequency domain and how the duty cycle percentage affects the spectrum . For the second experiment , it aims to teach students about FM demodulation using both ( Ʈ1, Ʈ2 ) and see how they affect the amplitude . Also , it’s aim is to study time response for modulating systems , time characteristic for input and output signals . Finally , one of the experiment objectives is to study the PM modulation and demodulation , study the modulated signal spectrum and compare between both PM modulation and FM modulation .

* **Table of Contents :**
* **Theory …………………………………………………………………..……………………………………. 3**
* **Diode Characteristics..………………………………………………………………..**
* **Rectificati………………………………………………………………. 4**
* **Applicato………………………..……………………………………………… 5**
* **Procedure …………………………………………………………………………………………………..…………… 7**
* **Diode Characteristics ………………………………………..……………………………………………. 7**
* **Rectification ………………..…………………………………………………………………………………. 8**
* **Half Wave Rectifier ……………………………………………………………………………………10**
* **Full Wave rectifier …………………………………………………………………………………... 12**
* **Applications ………………………………………………………………………………………………… 14**
* **Clipping Circuit ………………………………………………………………………………………. 14**
* **Clamping circuit ……………………………………………………………………………………….15**
* **Voltage Multiplier Circuit ……………………………………………………………………….. 16**
* **Conclusion …………………………………………………………………….……………………………………….. 17**
* **References ……………………………………………………………………………..………………………..…….. 18**

**Theory :**

**FM modulation ( Frequency modulation ) :**

For the information to be transmitted , first it must be converted from audio to electrical signals such that it can be transmitted though electrical channels . Signals can’t be transmitted the way they are , instead they are carried on another signal called carrier . This operation called modulation .

One of the important ways of modulation is FM modulation , it’s importance came from it is considered the better way of modulation that deals with noise rather than AM modulation .

In FM modulation ( which is a type of angle modulation beside Phase modulation ) , signal are carried on the frequency of the carrier . The amplitude of the carrier remains constant and Vm controls the frequency of the carrier .

The following equations clarifies the relationship :



Here , carrier frequency term has been replaced with a time-varying frequency. A new term is introduced witch is  Df (the peak frequency deviation) . In this form it’s obvious that the carrier frequency term: fc + (Df/Vmo) Vm (t) now varies between the extremes of fc- Df and fc+ Df. The interpretation of Df becomes clear: it is the farthest away from the original frequency that the FM signal can be. Sometimes it is referred to as the "swing" in the frequency.

Another important concept in FM modulation is modulation index ( bwhich equals

b = Df/fm, where fm is the maximum modulating frequency used.

bmodulation index ) is as a measure of the peak frequency deviation, Df. In other words, b represents a way to express the peak deviation frequency as a multiple of the maximum modulating frequency, fm ( i.e. Df = b fm ) .

PM modulation :

PM modulation is the second type of angle modulation , PM changes the phase angle of the [complex envelope](https://en.wikipedia.org/wiki/Complex_envelope) in direct proportion to the message signal.

Formula :

Supposing that the signal to be Modulated is :

 .

The modulated signal is :

And



{\displaystyle c(t)=A\_{c}\sin \left(\omega \_{\mathrm {c} }t+\phi \_{\mathrm {c} }\right).}

Phase modulation is similar in practice to frequency modulation ([FM](http://searchnetworking.techtarget.com/definition/frequency-modulation)). When the instantaneous phase of a carrier is varied, the instantaneous frequency changes as well. The converse also holds: When the instantaneous frequency is varied, the instantaneous phase changes. But PM and FM are not exactly equivalent, especially in analog applications. When an FM receiver is used to demodulate a PM signal, or when an FM signal is intercepted by a receiver designed for PM, the audio is distorted. This is because the relationship between phase and frequency variations is not linear , that is, phase and frequency do not vary in direct proportion.

Conclusion :

After doing this experiment , we were able to understand and distinguish between FM modulation and PM modulation . we were able to analyze the spectrum for both types , and study the factors that affects on changing the frequency and phase of the carrier . Also , we studied the time response for signal modulation . Then , we were able to get back the original message through demodulation operation . we have understood more than one method to retrieve data , and we used in lab , the closed loop method .

Finally , we are now able to analyze any spectrum of modulated signal for a ( sinusoidal signal , square wave signal , sinusoidal carrier and square wave carrier ) and we can distinguish the difference .

* **References :**

 **Angle modulation :**

* <https://en.wikipedia.org/wiki/Angle_modulation>.

 **PM modulation :**

* <http://whatis.techtarget.com/definition/phase-modulation-PM>

**FM modulation :**

* <http://fas.org/man/dod-101/navy/docs/es310/FM.htm>