2. STUDY OF FREQUENCY MODULATION (FM)

1. Course, Subject & Experiment Details

Academic Year	2018 – 2019	Estimated Time	Experiment No. 2 – 02 Hours
Course & Semester	S.E. (COMP) – Sem. III	Subject Name	Basic Electronics Lab
Chapter No. & Unit	04 – Unit 4.1 Mapped to CO- 1	Chapter Title	Frequency Modulation (FM)
Experiment Type	Hardware (Trainer Kits)	Subject Code	CSL 302

2. Aim & Objective of Experiment

This experiment enables the students to perform frequency modulation (FM) on a high frequency carrier signal of certain amplitude & frequency, thereby observing the actual output frequency modulated (FM) waveform. It also teaches them to calculate the modulation index or modulation coefficient (m_f) for different amplitude values of the modulating signal (V_m) & carrier signal (V_c) using available hardware trainer kits.

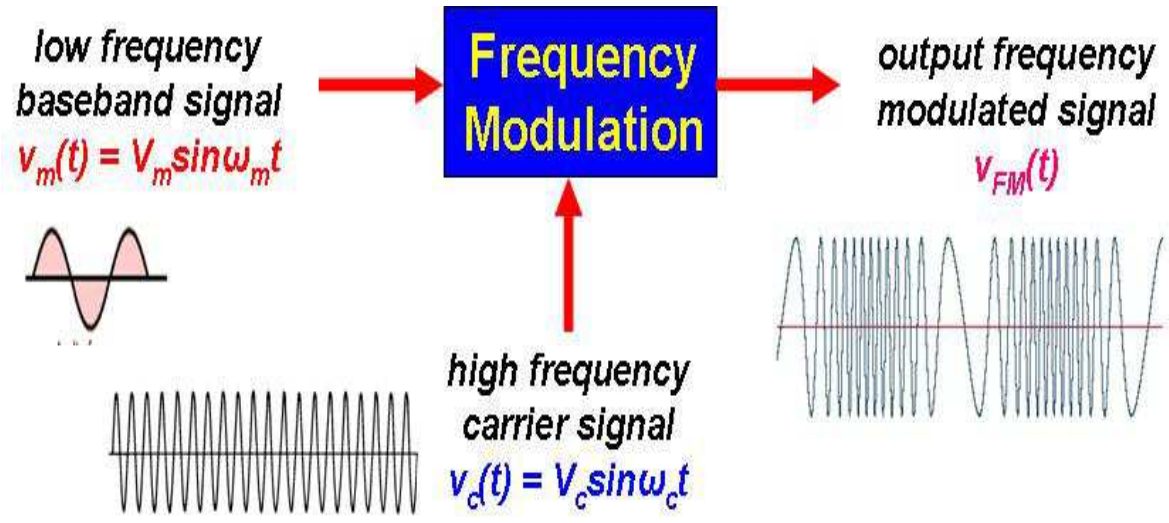
3. Expected Outcome of Experiment

The expected outcomes of this experiment include basic understanding of the process of frequency modulation (FM) which is performed by hardware trainer kits. The students are also expected to have the good hands-on practice of observing output frequency modulated (FM) waveform for the different values of modulation index or coefficient (m_f) understanding the practical process of FM generation & transmission.

4. Brief Theoretical Description

(a) Definition of Frequency Modulation (FM) :-

Frequency modulation (FM) is analog modulation technique in which the frequency of the high frequency carrier signal waveform is varied proportionally with respect to the instantaneous amplitude of modulating or baseband input signal, keeping the phase & amplitude of the carrier signal constant. Here both the input modulating & the carrier signals are analog in nature, being low frequency & high frequency respectively.



(b) Definition of Frequency Deviation (δ_{max}) :-

Frequency deviation (δ_{max}) in FM is the instantaneous change or variations in the frequency of the carrier signal proportionally with respect to the instantaneous amplitude of the input modulating baseband signal $v_m(t)$ for which the maximum frequency deviation (δ_{max}) is expressed by the following relationship :-

$$\delta_{max} = k_F V_m$$

k_F is constant (Hz/V) frequency sensitivity

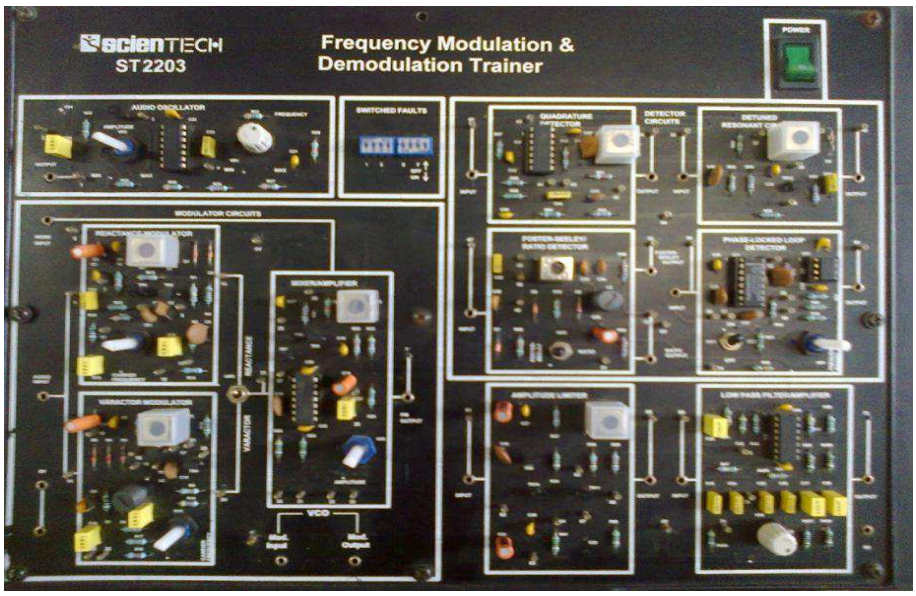
(c) Definition of Modulation Index (m_f) :-

In frequency modulation (FM) the modulation index (m_f) represents depth of modulation of the high frequency carrier signal frequency by instantaneous amplitude of input baseband (modulating) signal & is defined as ratio of maximum frequency deviation (δ_{max}) to modulating or baseband signal frequency (fm) :-

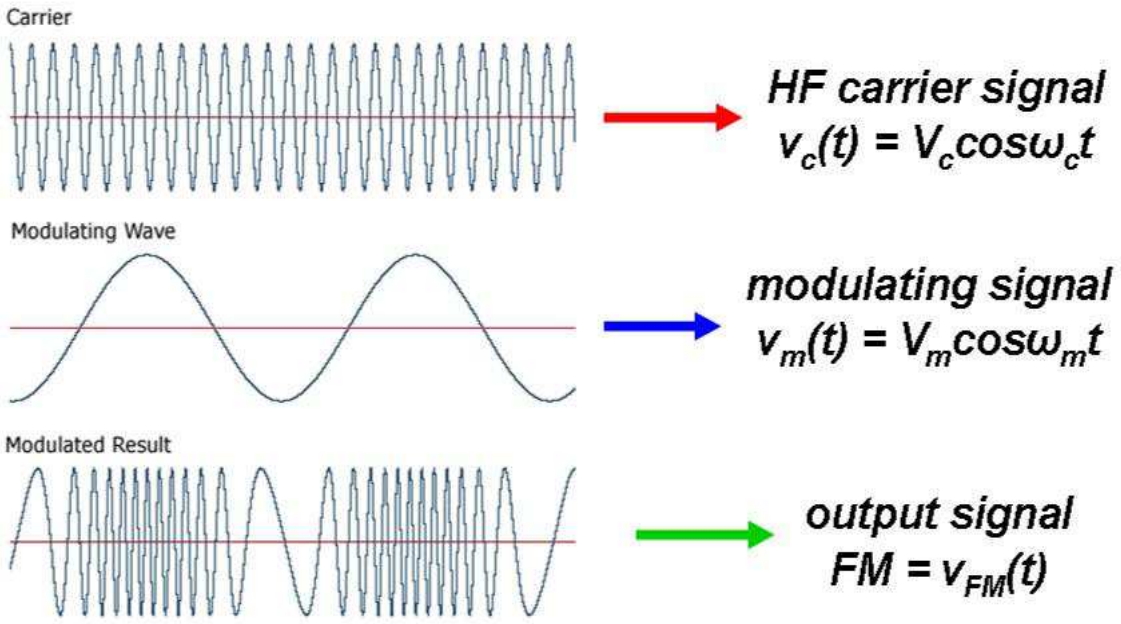
$$m_f = \frac{\delta_{max}}{f_m}$$

since frequency deviation & modulating signal frequency both carry the unit in Hz, it is a dimensionless quantity very much like the modulation index (m_a) of an AM wave

5. Circuit Diagram & Experimental Setup



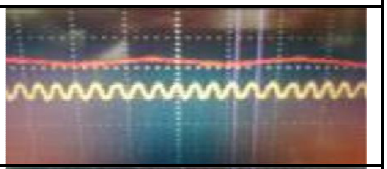
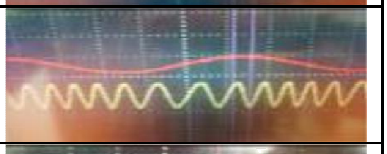
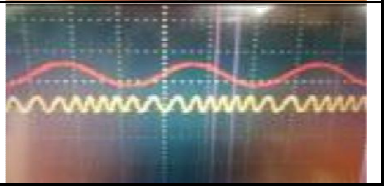
6. Input & Output Waveforms for FM



7. Experimental Procedure

1. Connect & turn on the power supply to the frequency modulation (FM) trainer kit.
2. Make appropriate connections as per instruction manual & obtain FM wave on CRO.
3. Adjust both frequency & amplitude of modulating & carrier signals & observe FM wave.
4. Measure & record the frequency deviations (δ_{max}) as seen or obtained from the CRO.
5. Measure the FM modulation index (m_f) for each type of waveform seen on the CRO.

8. Nature of Output Waveforms (FM)

No.	Condition for Frequency Deviation	Time Domain Representation of the FM Wave
1.	No Frequency Deviation	
2.	Low Frequency Deviation	
3.	High Frequency Deviation	

9. Conclusions & Inferences

Students should explain in brief the concluded outcome from the experiment & its inference, as obtained from the observation table & the nature of the graph which explains the system behavior

10. Practical & Real Life Applications

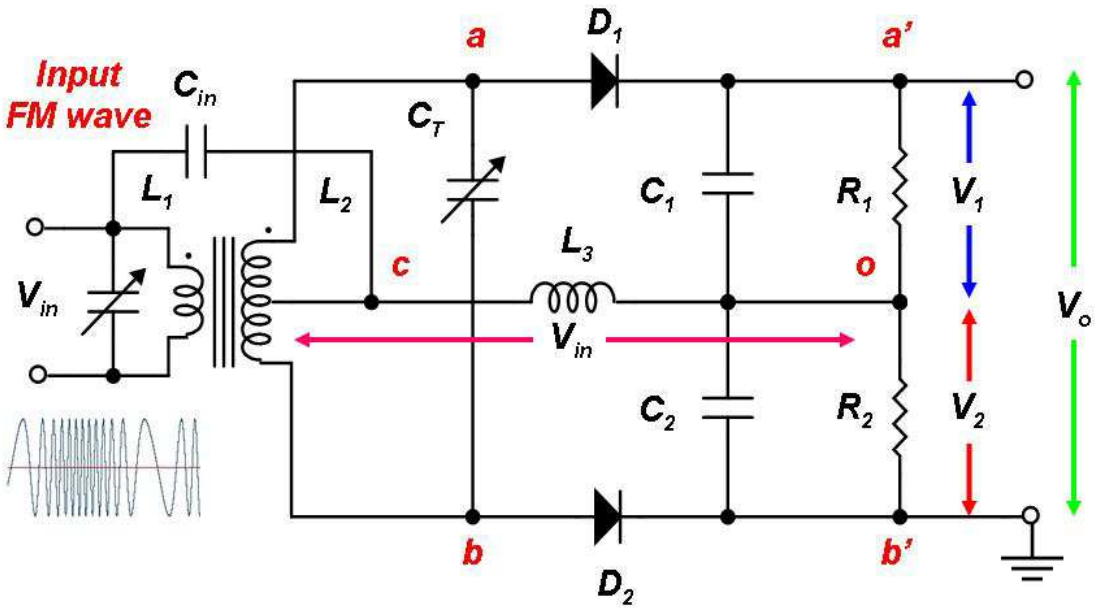
- Commercial Radio Broadcasting from 88 MHz to 108 MHz
- Audio Transmission (Sound Signal) in TV Broadcasting

11. Post Lab & Viva Questions

1. A frequency modulated (FM) signal waveform transmitted through a 5 : antenna is represented by the following equation $v_{FM}(t) = 10 \sin [16\pi \times 10^6 t + 20 \sin (2\pi \times 10^3 t)]$. Calculate the modulation index, the modulating signal frequency, carrier signal frequency, frequency deviation, bandwidth & total power in FM.

2. With neat labeled block diagram, draw & explain the superhetrodyne receiver used for the demodulation for frequency modulated (FM) signals. Differentiate it from AM superhetrodyne receiver.

3. The diagram shown below is that of Foster – Seeley Discriminator used for the detection / demodulation of frequency modulated (FM) signals. Explain the operation, in detail with suitable sketches.



4. Explain the concept of the phase locked loop (PLL). With a neat block diagram, explain how the phase locked loop (PLL) can be used for the detection / demodulation for frequency modulated (FM) waveforms.

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