Signal System and Communication Laboratory

Session 2020-21
Experiment No. 08

1 Aim

1) To generate frequency modulated signal and demodulate it (without MATLAB inbuilt function).

2 Hardware & Software Required

* Desktop/Laptop
* MATLAB

3 Theory

3.1 FM Modulation

Frequency Modulation is the process of varying the frequency of the carrier signal linearly with the message signal.

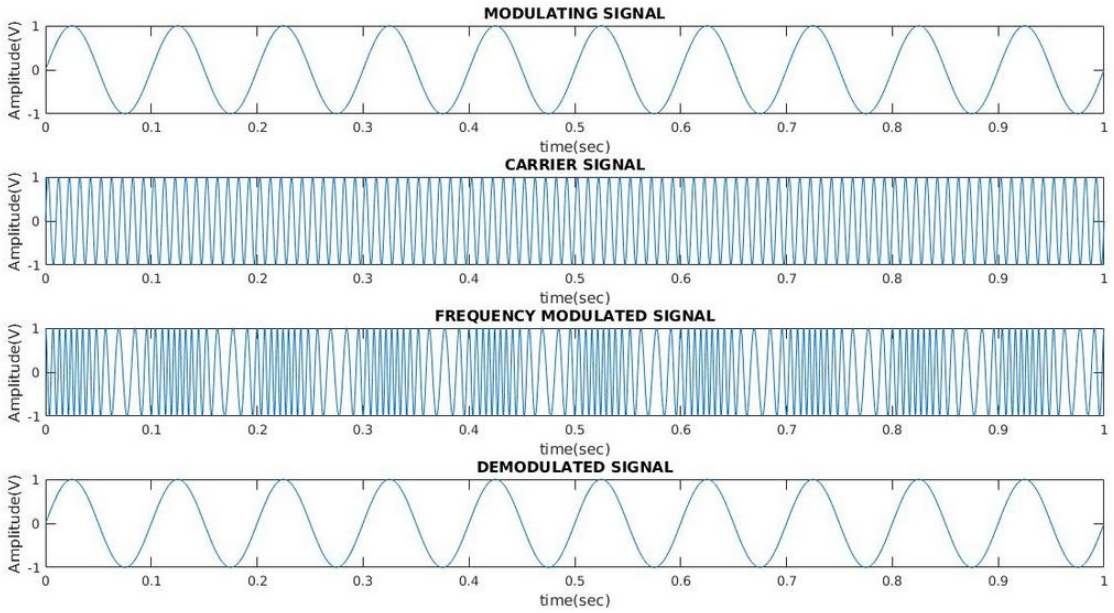

Figure 1: FM modulated and demodulated waveforms

Consider a message signal defined by $s(t) = A_m \ cos \ 2\pi f_m t$. The instantaneous frequency of the FM signal is expressed as

$$\begin{aligned} f(t) &= f_c + k_f \ A_m \ cos \ 2\pi f_m t \\ &= f_c + \Delta f \ cos \ 2\pi f_m t \end{aligned} \tag{1}$$

where $\Delta f = k_f A_m$ is the maximum frequency deviation that occurs in the carrier frequency.

Modulation index β is

$$\beta = \frac{\Delta f}{f_m} = \frac{k_f A_m}{f_m} \tag{2}$$

The quantity β is a dimensionless quantity since k_f has the units of $volt^{-1}$ $second^{-1}$. The FM signal is given by

$$s_{FM}(t) = A_c \, cos[2\pi f_c t + \beta sin \; 2\pi f_m t] \tag{3}$$

3.2 FM Demodulation Techniques

3.2.1 Coherent & Non-coherent

- A coherent detector has two inputs - one for a reference signal, such as the synchronized oscillator signal, and one for the modulated signal that is to be demodulated.
- A non-coherent detector has only one input, namely, the modulated signal port.

3.2.2 Demodulator Classification

1. Frequency Discrimination
   - Noncoherent demodulator
   - $FM \rightarrow AM \rightarrow ED \rightarrow m(t)$
2. Phase Shift Discrimination
   - Noncoherent demodulator
   - $FM \rightarrow PM \rightarrow m(t)$
3. Phase-Locked Loop (PLL) Detector
   - Coherent demodulator
   - Superior performance; complex and expensive

4 Exercises

1. Generate FM waveform in time domain and frequency domain.
2. Generate FM demodulated waveform in time domain and frequency domain.