# MAWLANA BHASHANI SCIENCE AND TECHNOLOGY UNIVERSITY

## SANTOSH, TANGAIL-1902


## DEPARTMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY

## Lab Report No: 03

**Course Title:** Communication Engineering Lab

**Course Code:** ICT-2206

**Lab Report on:** Frequency Modulation and Demodulation

| Submitted By | Submitted To |
|---|---|
| **Name: Kuldip Saha Mugdha**<br>**ID: IT-22018**<br>**2nd Year, 2nd Semester**<br>**Session: 2021-2022**<br>**Dept. of ICT, MBSTU** | **Dr.Monir Morshed**<br>**Professor**<br>**Department of Information and Communication Technology**<br>**Mawlana Bhashani Science and Technology University** |

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**Introduction:**

Frequency Modulation (FM) is a technique where the frequency of a carrier wave is varied according to the amplitude of the message signal. FM is widely used in radio broadcasting, two-way radio communication, and TV audio transmission due to its high noise resistance and improved sound quality compared to Amplitude Modulation (AM).

**Equipments:**

1.Signal Oscillator

2.MATLAB

3.Oscilloscope

4.Function generator

5.Connecting wires

6.Power supply

**Theory:**

In Frequency Modulation (FM), the frequency of the carrier wave changes in proportion to the instantaneous amplitude of the message signal. The FM signal is given by:

$$s(t) = A_c \cos\left(2\pi f_c t + k_f \int m(t)dt\right)$$

where:

- $A_c$ = Carrier amplitude
- $f_c$ = Carrier frequency
- $k_f$ = Frequency deviation constant
- $m(t)$ = Message signal

The modulation index (β) determines how much the frequency deviates from its center frequency and is given by:

$$\beta = \frac{\Delta f}{f_m}$$

where Δf is the frequency deviation and $f_m$ is the message frequency.

Demodulation can be performed using a frequency discriminator or a Phase-Locked Loop (PLL) to recover the original message signal.

**Procedure:**

**Generate Signals**

- Create a message signal (low-frequency sine wave).
- Generate a carrier signal (high-frequency cosine wave).

**2. Apply Frequency Modulation**

- Vary the frequency of the carrier in proportion to the amplitude of the message signal.
- Observe the effect of different modulation indices on the FM signal.

**3. Visualize the Signals**

- Plot the message signal, carrier signal, and FM signal.
- Analyze frequency variation in the FM waveform.

**4. Transmission of FM Signal**

- Simulate the transmission process in MATLAB.

**5. Demodulation Process**

- Use a frequency discriminator or a Phase-Locked Loop (PLL) to extract the message signal.
- Compare the demodulated signal with the original message.

**6. MATLAB Implementation**

- Implement frequency modulation and demodulation using MATLAB.
- Display the output waveforms for analysis.

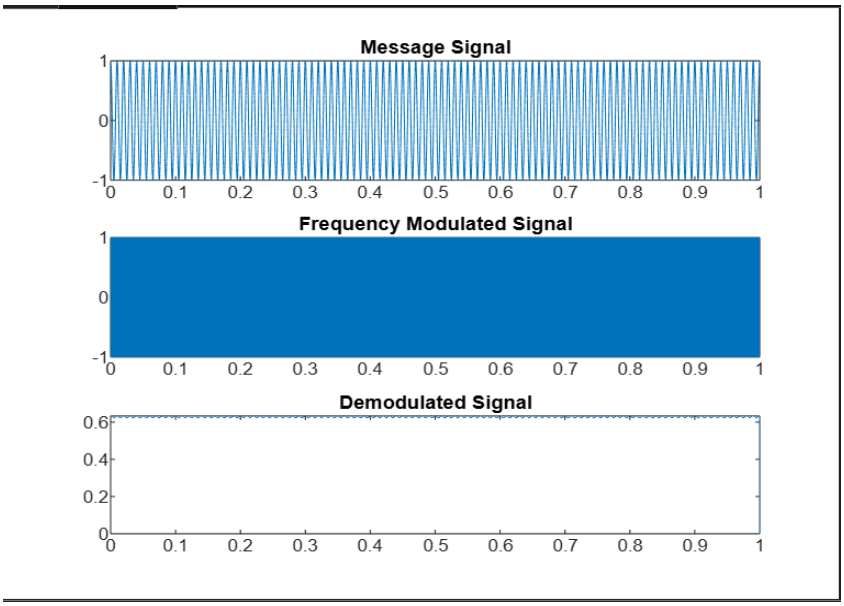
**MATLAB code:**

```
Fs = 10000; Fm = 100; Fc = 1000; Ac = 1; kf = 50; T = 1;
t = 0:1/Fs:T-1/Fs;
message_signal = cos(2 * pi * Fm * t);
modulated_signal = Ac * cos(2 * pi * Fc * t + kf * cumsum(message_signal)/Fs);

% Demodulation using differentiation
demodulated_signal = [diff(unwrap(angle(hilbert(modulated_signal)))) 0];

figure;
subplot(3,1,1), plot(t, message_signal), title('Message Signal');
subplot(3,1,2), plot(t, modulated_signal), title('Frequency Modulated Signal');
subplot(3,1,3), plot(t, demodulated_signal), title('Demodulated Signal');
```

**Output:**



**Discussion:**

This lab successfully demonstrated Frequency Modulation (FM) and its demodulation using MATLAB. The results showed how frequency varies with the message signal and how PLL-based demodulation accurately recovers the original signal. FM is widely used in radio and communication systems due to its robustness against noise and interference.