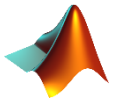
BUE The British University In Egypt الجامعة البريطانية في مصر	**Electrical & Communications Engineering Department** **Module Name: Analog Communication** **Module Code: 23ECE12I** **Semester: Two 22-23**
Matlab Laboratory 	**Lab Title: Frequency Modulation** **Lab No.: 3 (Week 5)**

Theory:

The process, in which the frequency of the carrier is varied in accordance with the instantaneous amplitude of the modulating signal, is called "Frequency Modulation". The FM signal is expressed as:

$$x_{FM}(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} s(\alpha)d\alpha\right]$$

Objectives:

1) To understand the modulation process and utilize FM to modulate the carrier signal.
2) To understand the FM demodulation process using frequency discriminator.

Prerequisites:

1) Basic familiarity with Simulink and Matlab environment.

Procedures:

The FM modulator parameters as follows:

- The frequency deviation constant $k_f = 10\ Hz/V$,
- The carrier frequency $f_c = 25\ Hz$,
- The modulating waveform $s(t) = cos(2\pi t)$.

Task 1: (FM Modulation)

1) Use Matlab's simulink to generate a sine wave (The message signal) with frequency of 100 Hz, sample time of .01 sec, and 2 volts peak.
2) The message signal is processed by the cascade of Integrator block.

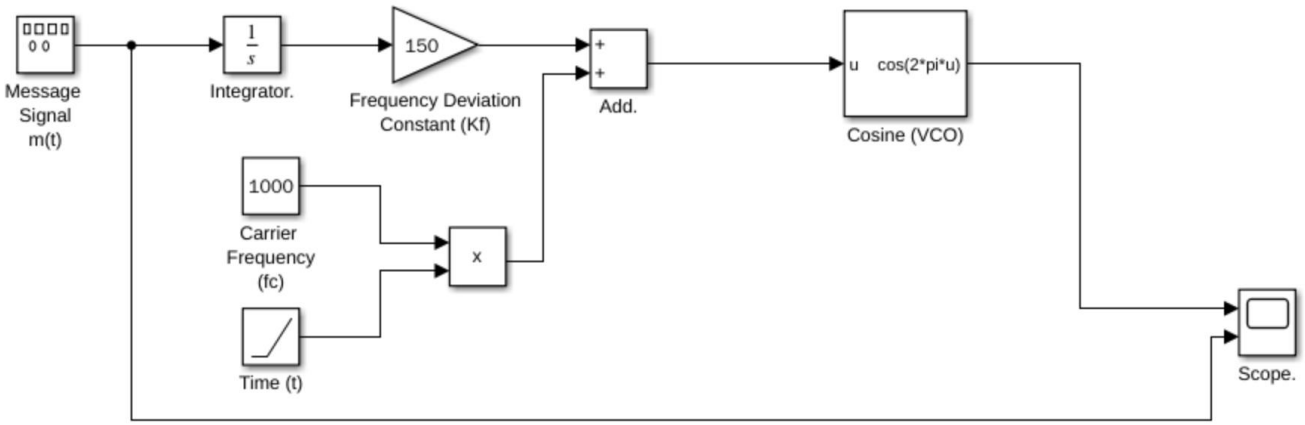


Figure1 Task 1 FM Modulator Connection Diagram

3) Use a Gain block (from Math Operations library) to with gain value equal to K_f, to multiply the Integrator output by K_f.
4) Use a Ramp and constant (f_c = 1000 Hz) blocks from Simulink Sources library to produce the term $f_c\ t$.
5) Use Add block to combine the Gain block and Product block outputs.
6) The combined signal is applied to a Cosine function block from to produce the FM signal.
7) the Cosine Functions block represents the Voltage Controlled Oscillator (VCO) (Functions = $cos(2 \times pi \times u)$, where u is the block input).
8) Display both inputs and the resulting Frequency modulated signal simultaneously on oscilloscopes, and spectrum Analyzer.
9) Draw the two signals showing axes values and amplitudes.
10) Change the amplitude of the modulating signal upwards and downwards while fixing the amplitude of the carrier, and draw the two signals in each case (Use four different frequencies)
11) Repeat the above step but this time changes the frequency deviation constant.
12) Comment on the effect of changing the signal amplitude and the frequency deviation index on the resulting modulated signal.

Task 2: (FM Demodulation)

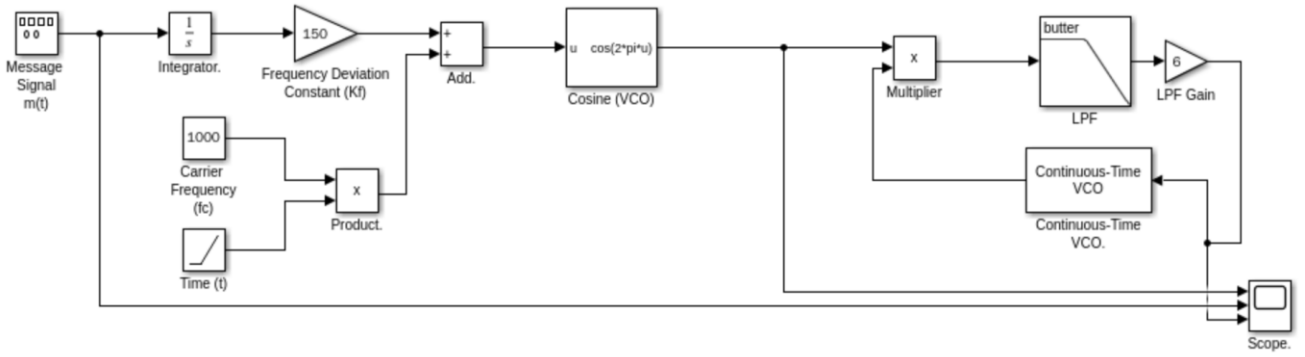


Figure2 Task 2 FM Demodulator Connection Diagram

1) Implement the FM demodulator model utilizes the frequency discriminator as shown in figure.
2) You need the modify the filter and the VCO parameters as shown in the screenshots:

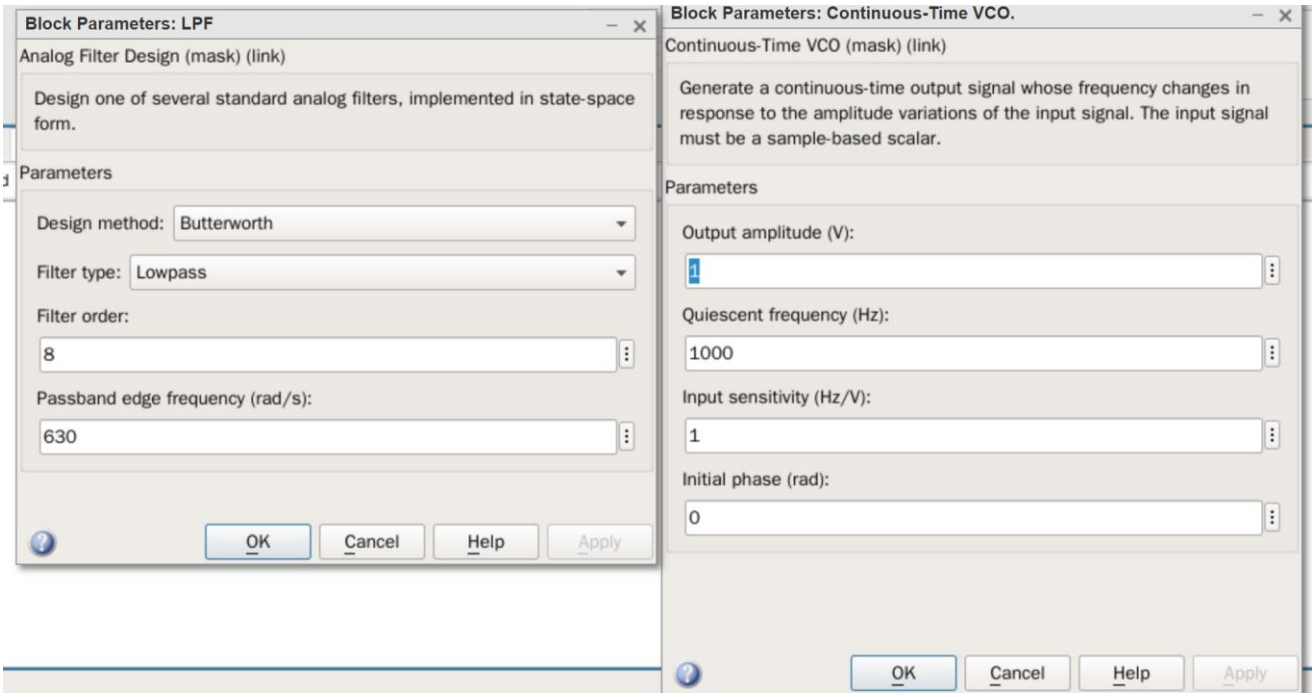


Figure 3 Task 2 FM Demodulator configuration

3) Change the amplitude of the modulating signal upwards and downwards while fixing the amplitude of the carrier, and draw the original message and the demodulated signals in each case (Use four different frequencies)

Report:

Attach a report listing all your answers, drawings, and comments indicating question numbers.

Performance Measure:

Participation	Quality of Answers
15	15