Faculty of Engineering and Technology
Electrical and Computer Engineering Department
Communication Laboratory
ENEE4113

Prelab Exp1 Normal Amplitude Modulation and Demodulaiton

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Section: 6

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Software Prelab (Simulink Matlab):

- **Build a full simulation block diagram of the modulation and the demodulation of the Normal AM that shows both the time and frequency domains. The diagram must show (message, carrier, modulated and demodulated) signals. Use two demodulation methods (coherent and envelope detector).**

Message signal:

$$m(t) = 0.85\cos(2\pi(1000)t)$$

Carrier signal:

$$c(t) = 1\cos(2\pi(15k)t)$$

Modulator sensitivity (k):

k **= varies according to the modulation index**

The demodulated signal = Ac` [1+μ cos(ωmt)].

So: Am=0.85 / Fm=1000

Ac=1 / Fc=15000

<u>Normal Amplitude Modulation</u>

- Modulation Index → μ=KaAm

- The modulated signal → S(t) = Ac [1 + ka * m(t)] * Cos(2 * π * fm * t)
- According to what is given:
  - The message signal → m(t) = 0.85 * Cos(2 * π * 1000 * t)
  - The carrier signal → c(t) = Cos(2 * π * 15k * t)

- Therefore S(t) = 1 * [1 + ka * 0.85 * Cos(2 * π * 1000 * t)] * Cos(2 * π * 15k * t)

❖ Modulation of normal AM block diagram:

Time domain:

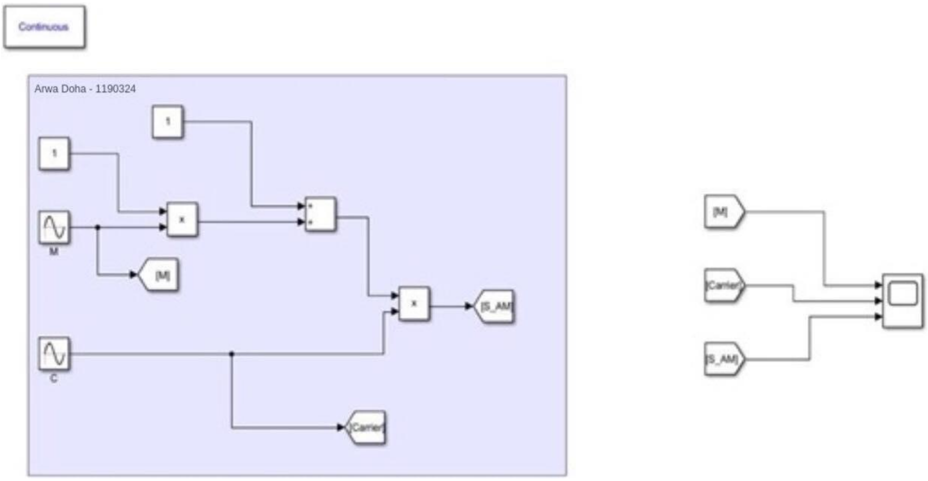

Fig1: Normal AM block in time domain

Frequency Domain:

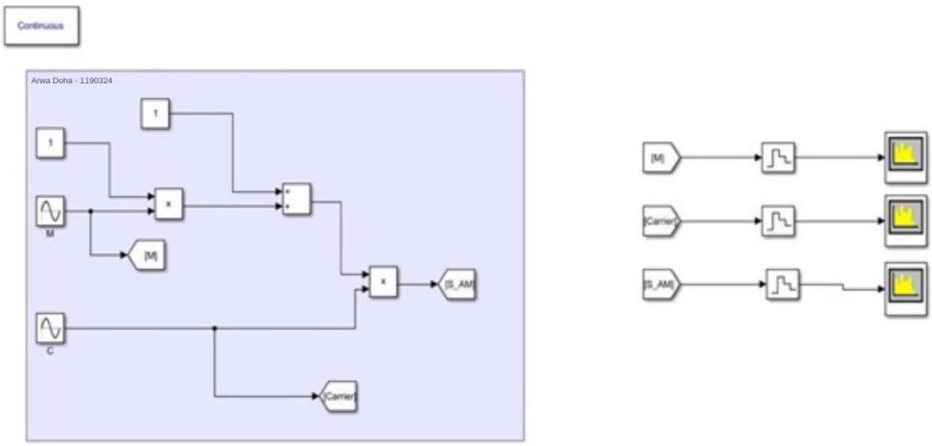

Fig2: Normal AM block in frequency domain

In Time domain:

1. m(t):Massage signal
2. c(t):Carrier signal
3. s(t):Modulated signal

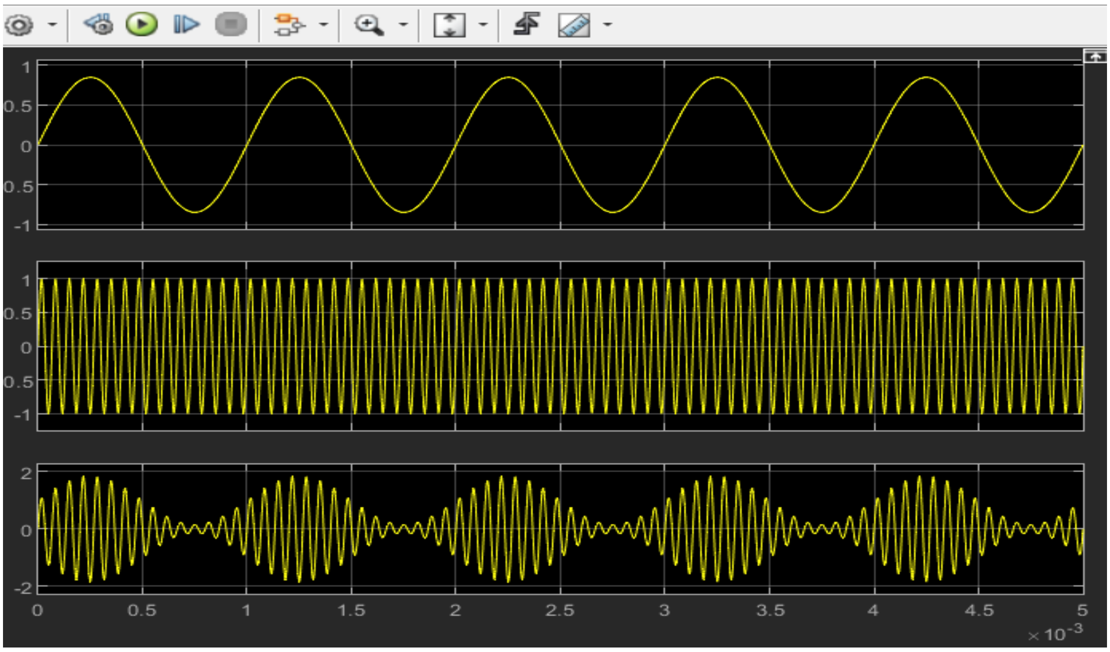

Fig3: In time domin m(t)/c(t)/s(t)

As depicted in the above figure, the amplitude of the modulated signal varies according to the expression Ac[1 + ka * m(t)]. To compute the modulation index, we can use the formula:

Modulation Index = (Amax - Amin) / (Amax + Amin)
= (1.425 - 0.575) / (1.425 + 0.575)
= 0.85 / 2
= 0.425.

Since **μ<1**, it falls into the category of under modulation.

In Frequency domain:

- **Massage signal→m(t):**

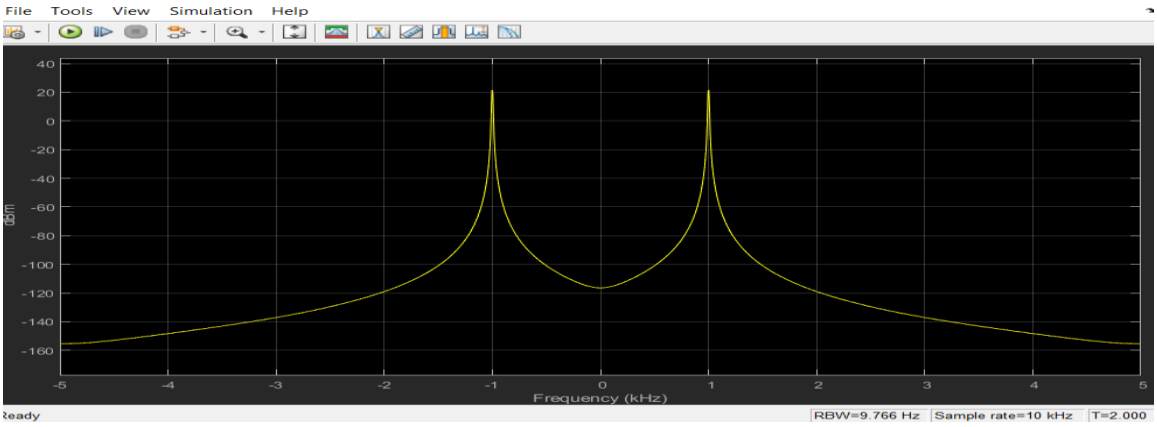

Fig4: in frequency domain m(t)

- **Carrier signal→c(t):**

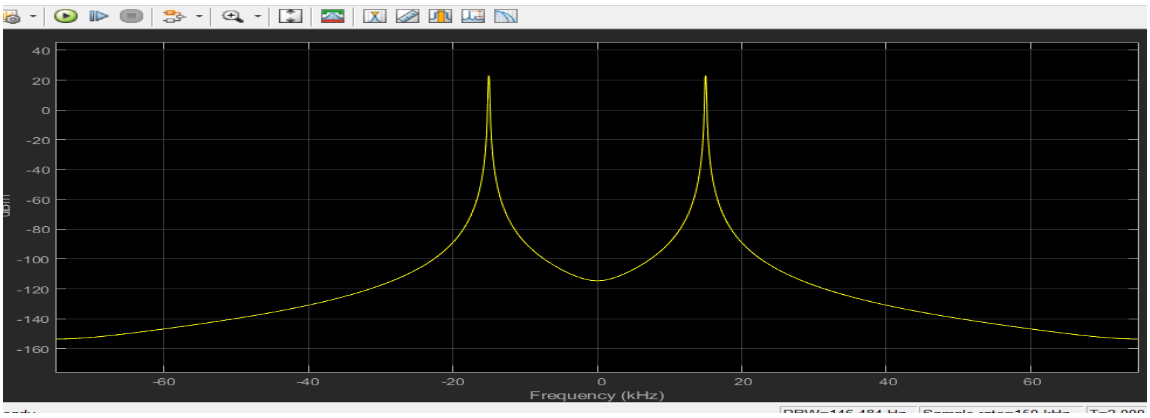

Fig5: c(t) in frequency domain c(t)

- Modulated signal→S(t):

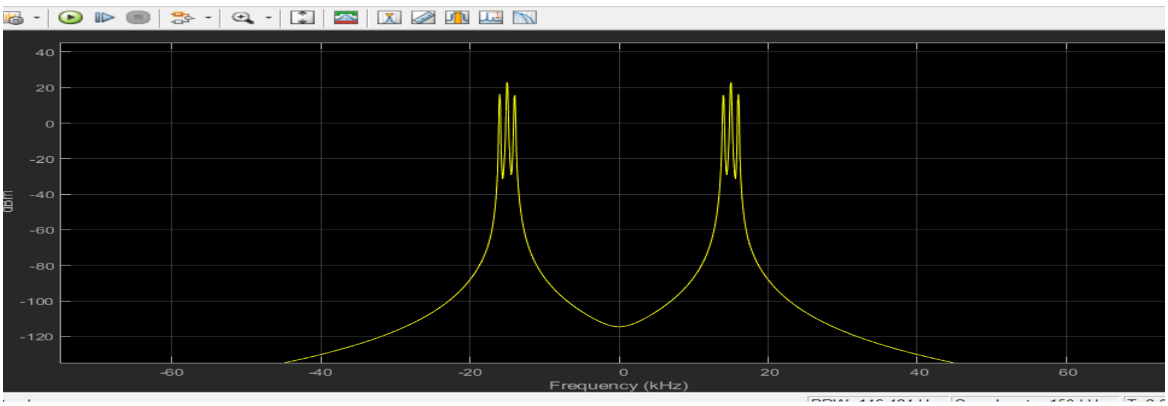

Fig6: in frequency domain s(t)

1. When ka==0.590 →

Block Diagram

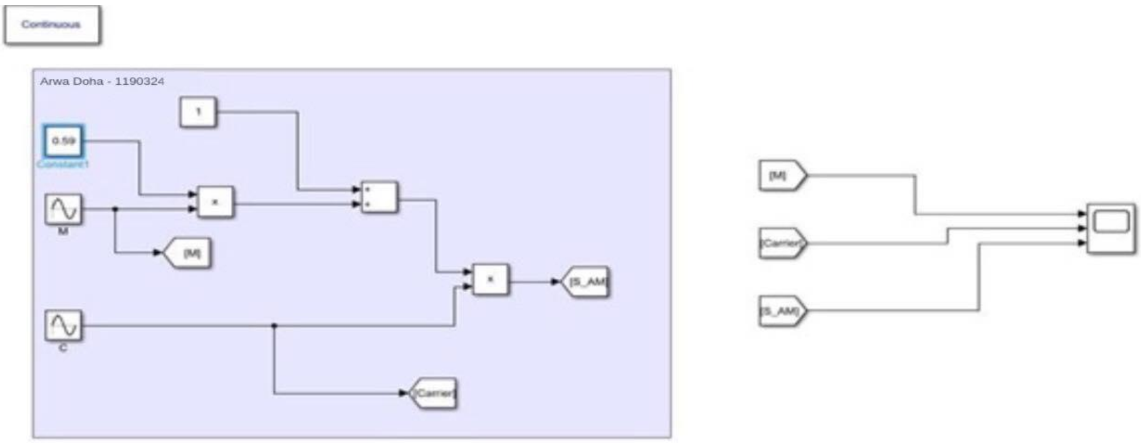

Fig7: block diagram when k=0.590

In time domain:

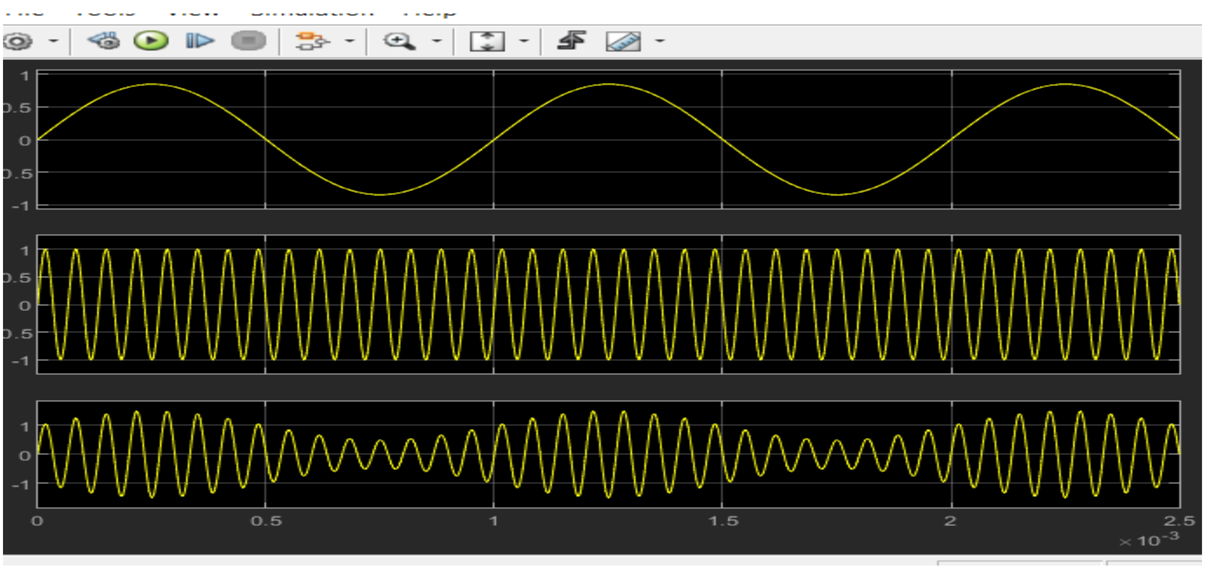

Fig8: time domain,when k==0.590

In this scenario, **μ<1** indicates that the carrier amplitude is not fully modulated.

2. When Ka = 1.18 →

Block Diagram :

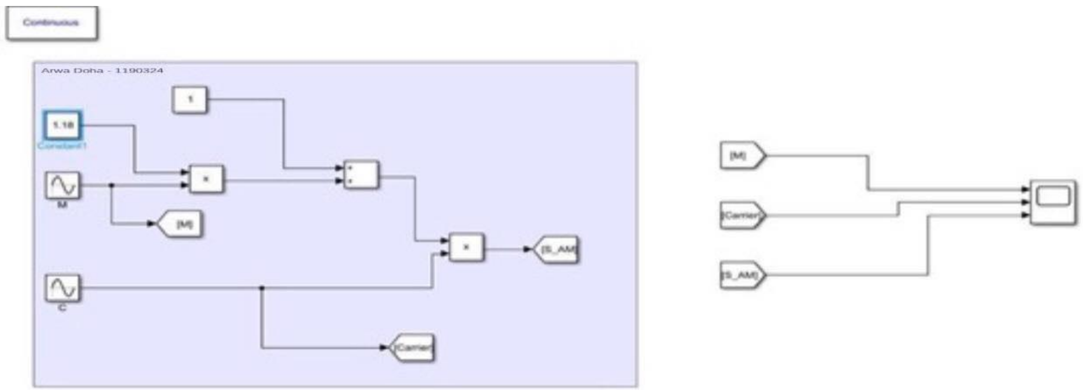

Fig9: block diagram when k=1.18

In time domain:

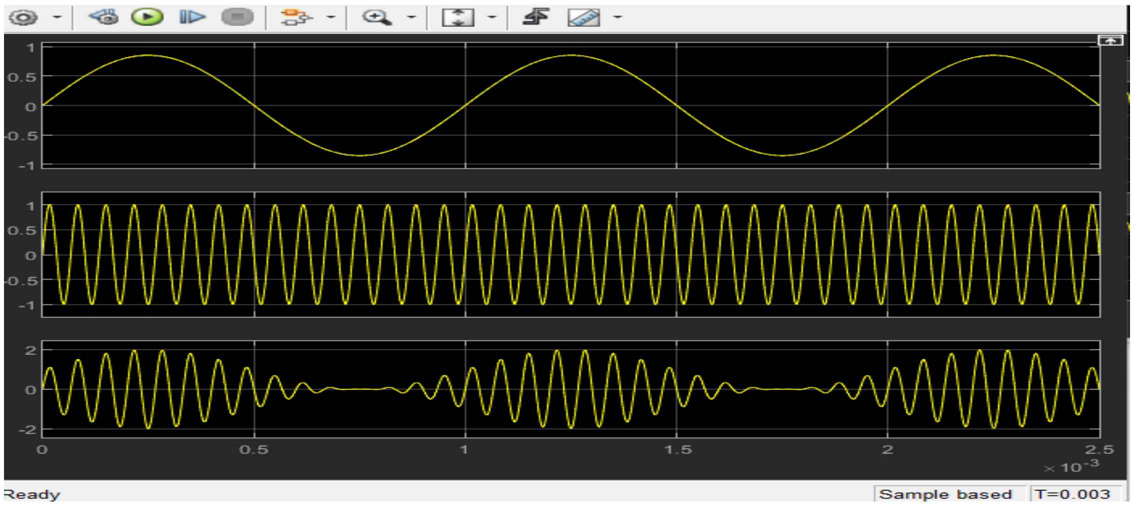

Fig10: time domain when ka=1.18

3. When Ka = 2.23 →

Block Diagram :

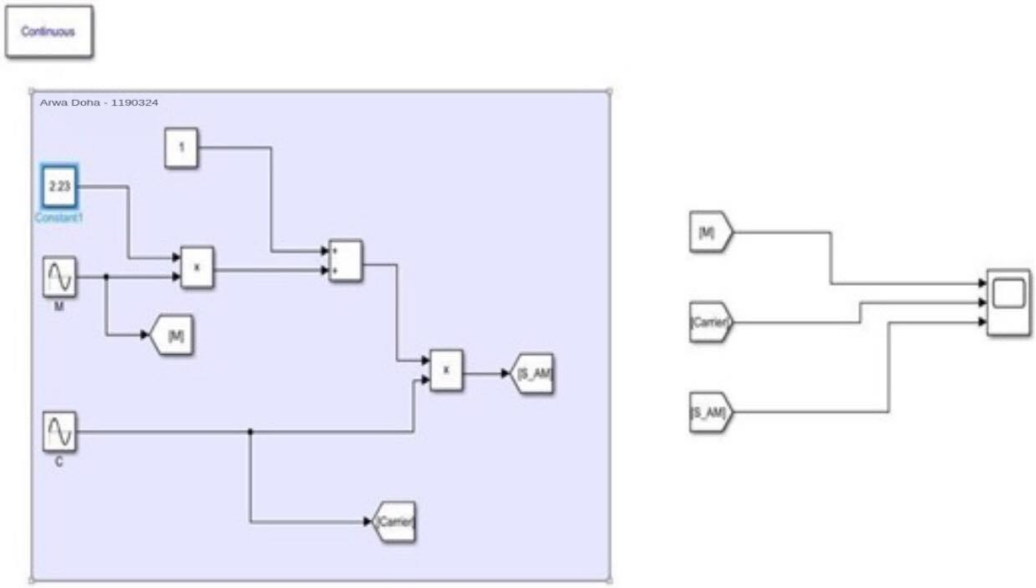

Fig11: block diagram,when k=2.230

In time domain:

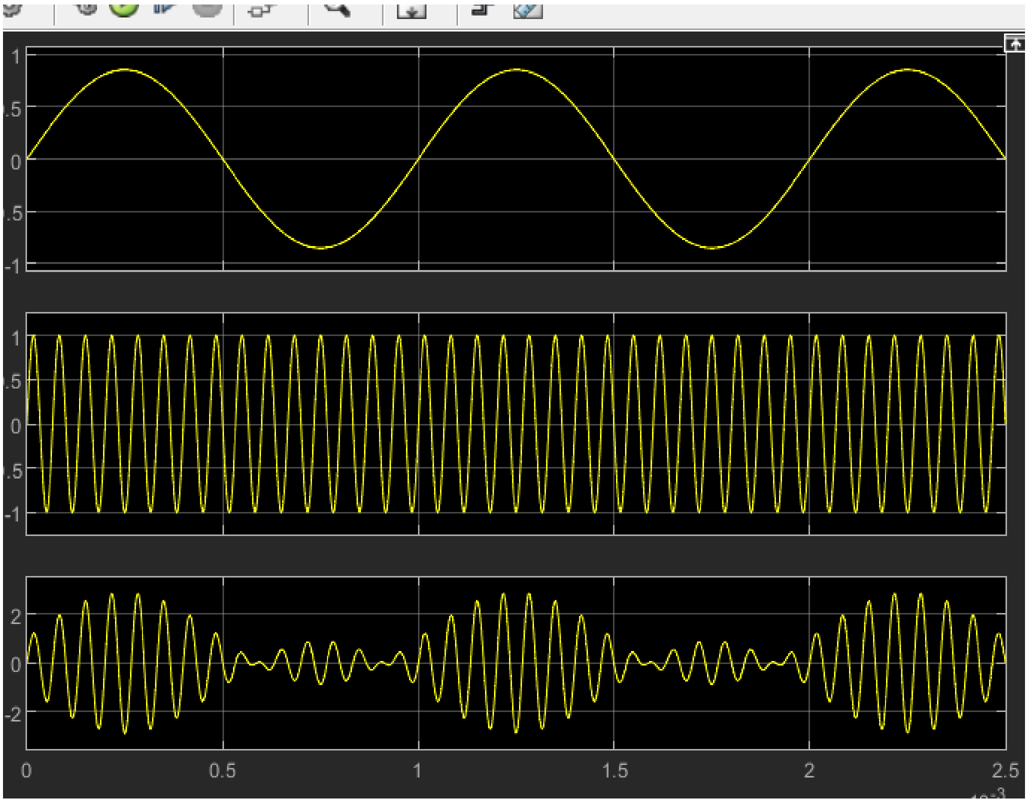

Fig12: time domain,when ka=2.23

When the modulation index exceeds 1, it signifies over-modulation of the carrier amplitude. This can result in signal distortion and the creation of sidebands.

- ## Coherent Demodulation

Demodulation is achieved by connecting the AM signal from the first half to an analog filter with a cutoff frequency higher than the lowest frequency present in the message signal.

Block of Demodulation :

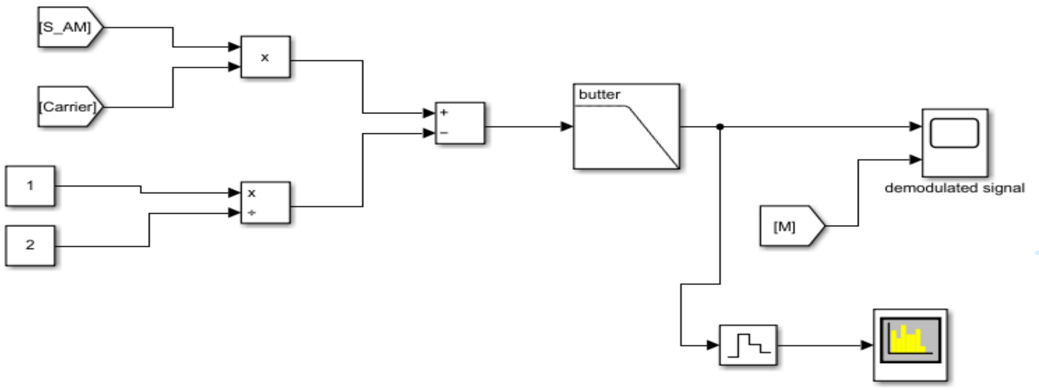

Fig13: coherent demodulation block

Show Demodulation Signal and Massage Signal:

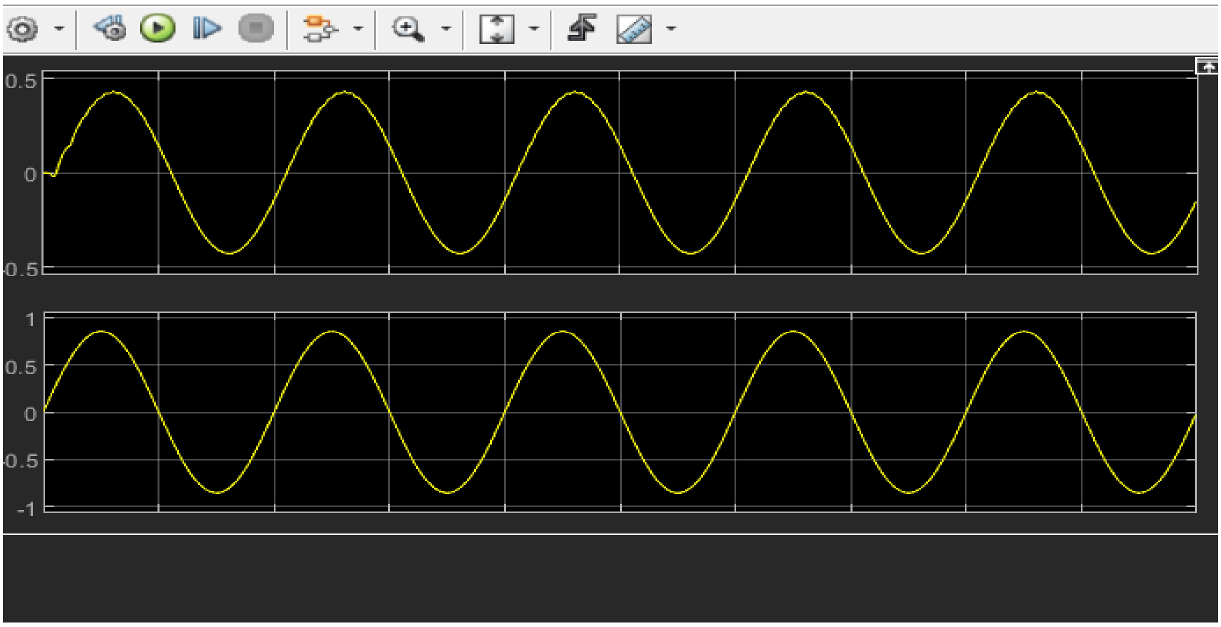

Fig14: signals of message signal and demodulation signal

In Spectrum:

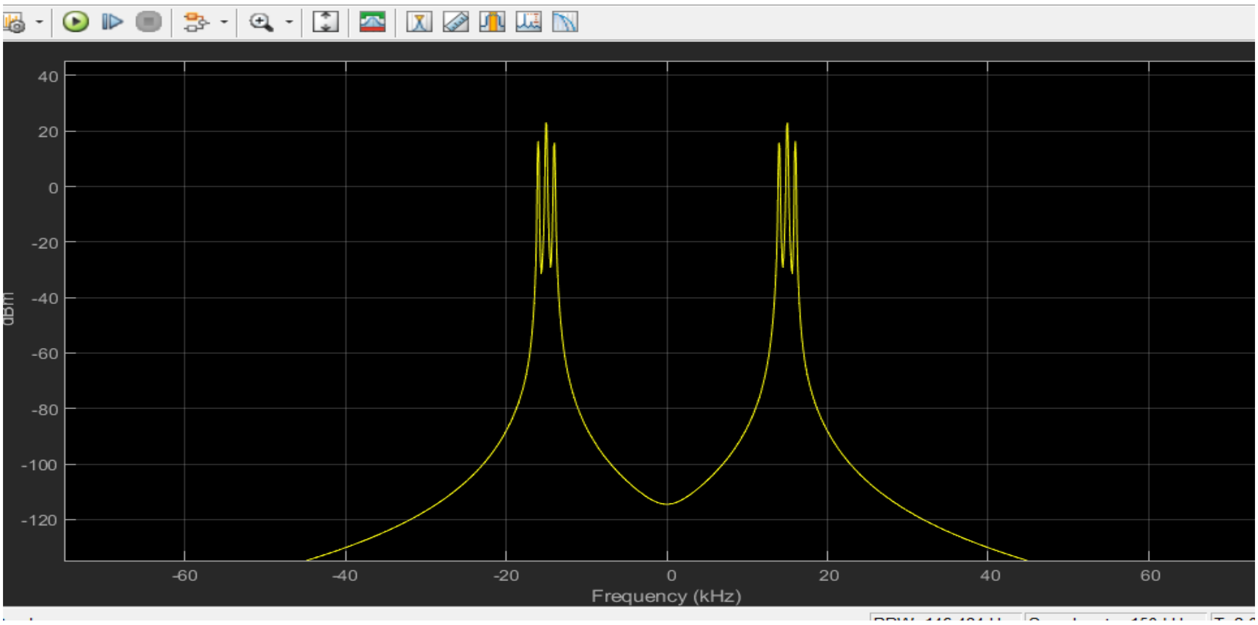

Fig15: result in spectrum

❼ Coherent_Demodulation →when ka=0.590

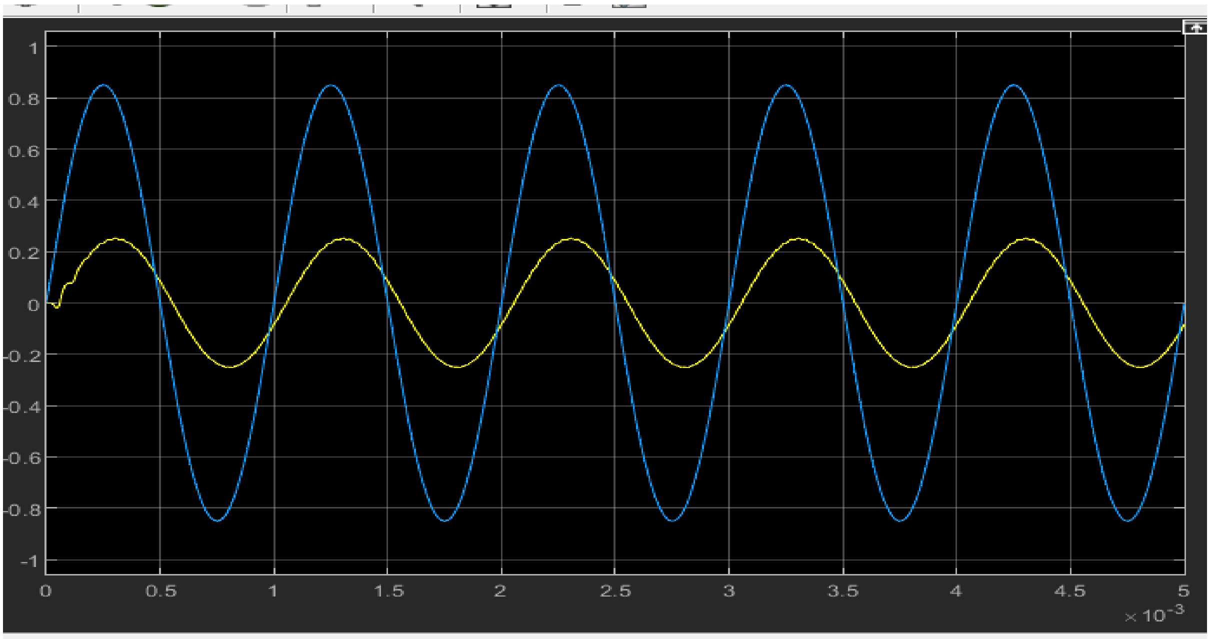

Fig16: demodulation coherant,when ka=0.590

The coherent demodulator effectively retrieves the original message signal by multiplying the received signal with a synchronized carrier signal. This process yields a reconstructed message signal in the time domain that closely resembles the original signal.

❼ coherent_demodulation_when ka=1.180

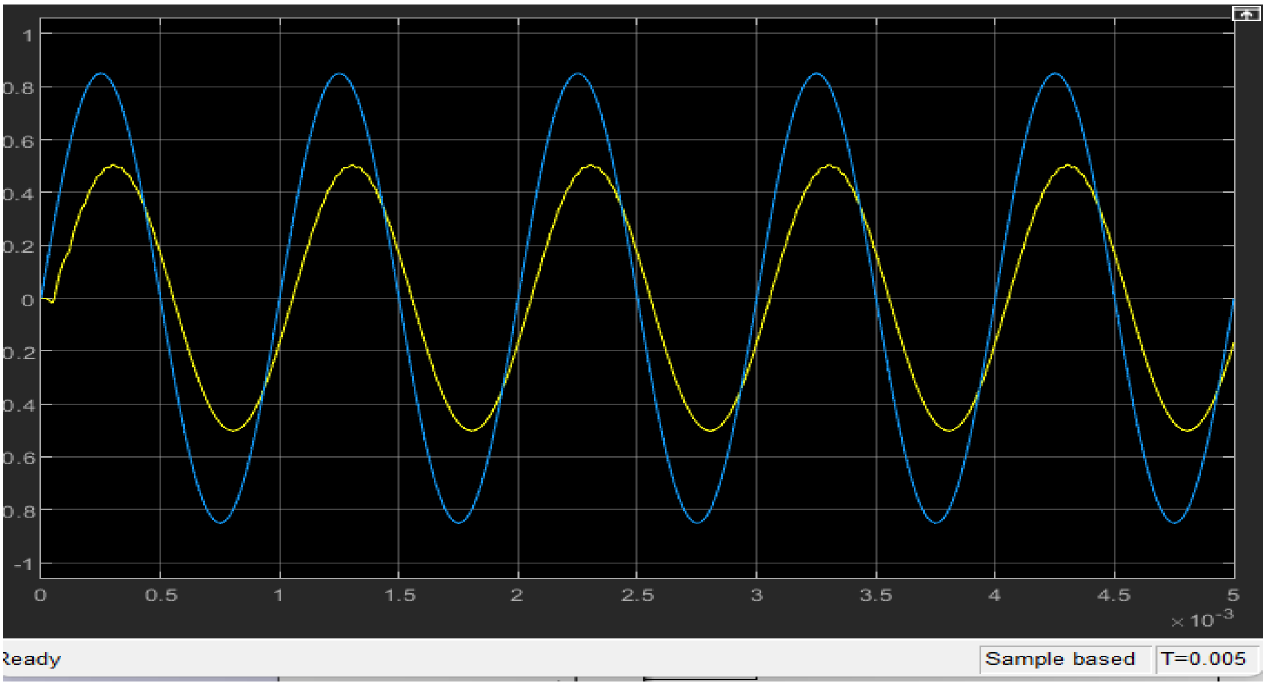

Fig17: coherentdemodulation,when ka =1.180

❼ coherent demodulation→when ka=2.23

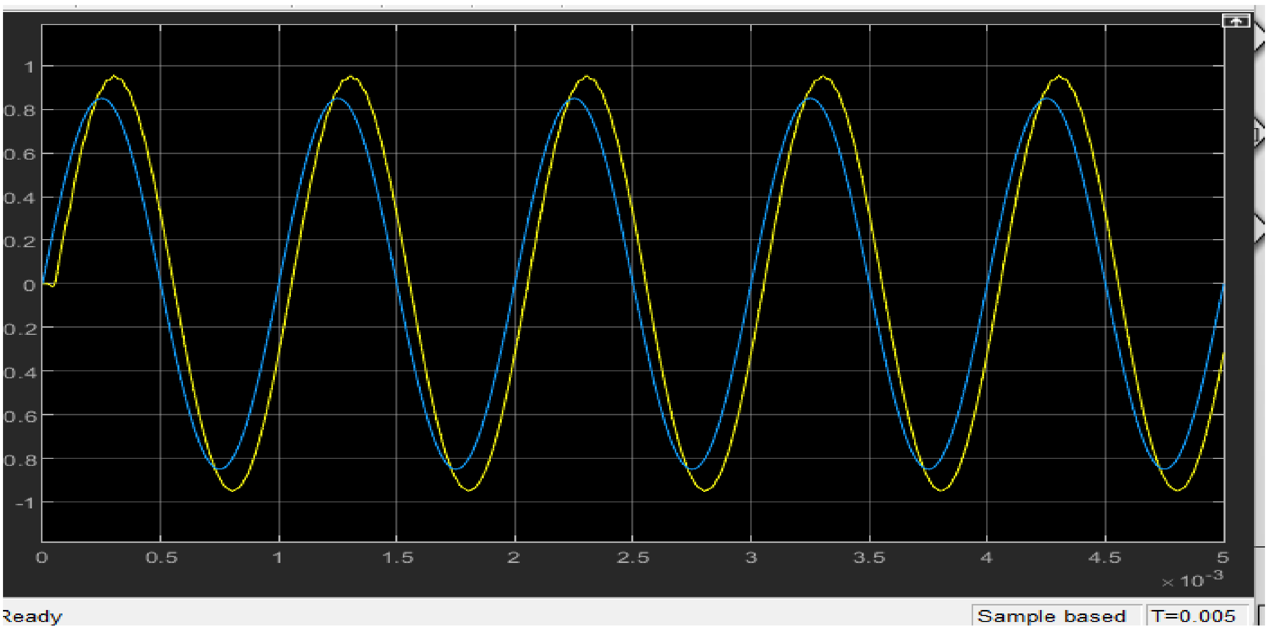

Fig18: coherent demodulation,when ka =2.23

The coherent demodulator faces challenges in accurately recovering the original message signal, primarily because of the presence of sidebands. This results in distortion and a noticeable loss of fidelity in the demodulated signal.

Envelope Demodulation:

Envelope Demodulation block Diagram :

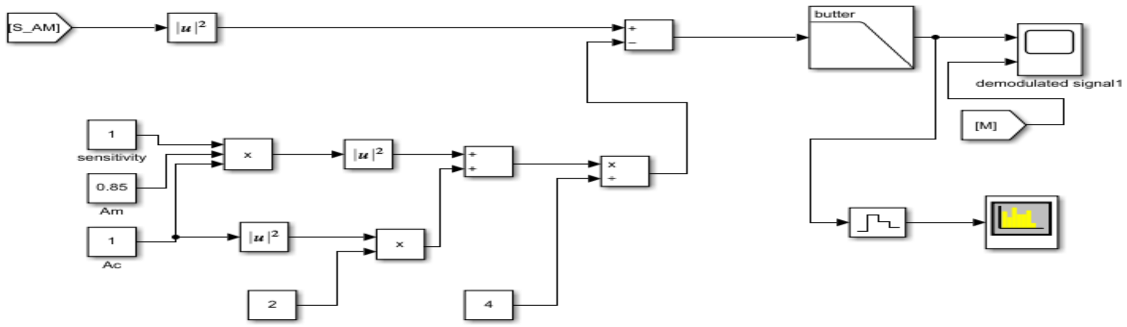

Fig19 envelope demodulation block Diagram

Demodulation signal and massage Signal:

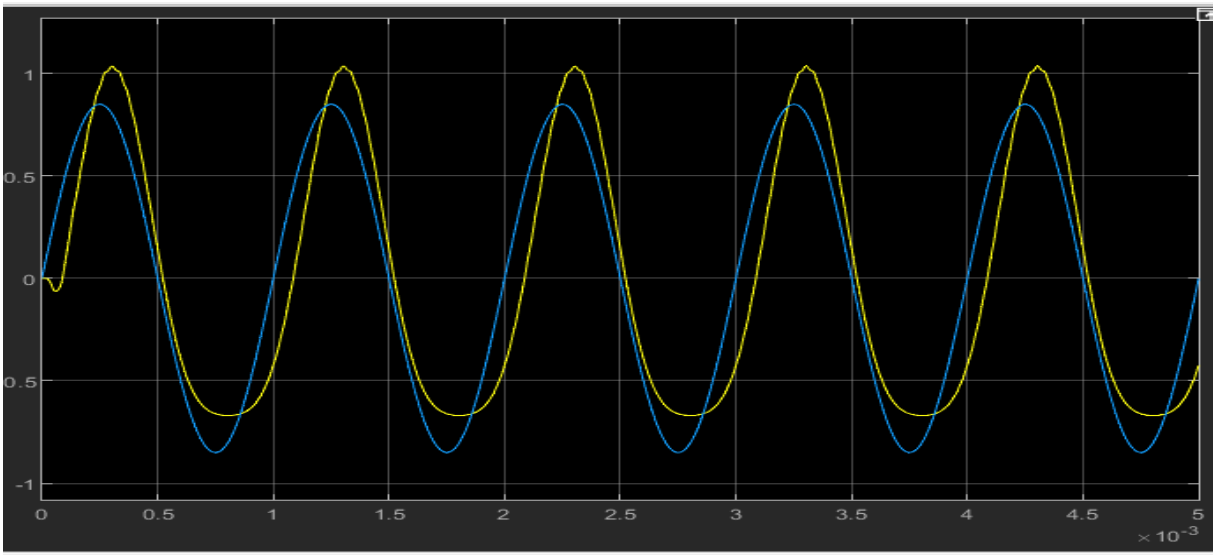

Fig20: demodulation signal and message signal

Notice that the message and its demodulated signal are_equally the same