EE 321 Lab Report

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AIM :-

1. Generation of AM Modulated signal using AD633 multiplier IC.
2. Demodulation of AM modulated signals using peak detector circuit.

THEOROTICAL BACKGROUND: -

AM modulation is a type of modulation in which the amplitude of the carrier signal is varied or modulated according to the amplitude of the message signal to obtain the modulated signal.

Let the modulating signal be,

$$m(t) = Amcos(2\pi fmt)$$

and the carrier signal be,

$$c(t) = Accos(2\pi fct)$$

Here,

Am and Ac are the amplitude of the modulating signal and the carrier signal respectively.
fm and fc are the frequency of the modulating signal and the carrier signal respectively.

Then, the equation of Amplitude Modulated wave will be

$u(t)=[Ac+Amcos(2\pi fmt)]cos(2\pi fct)$

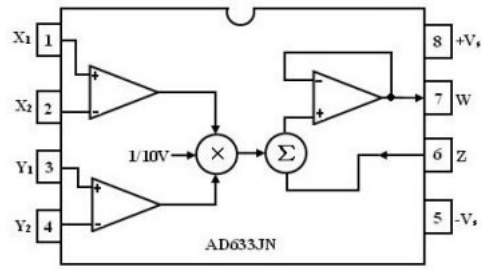
Modulation Index – It tells us the level of modulation that the carrier wave undergoes.

$u = (Amax – Amin)/(Amax + Amin)$

For all practical purposes we can also calculated modulation index as $u = Am/10$.

Demodulation is a process of obtaining the message signal back from the modulated signal. We can obtain the message signal by passing it through envelop detector circuit that is first rectifying it through a diode and passing it through a low pass fitter whose bandwidth matches with that of message signal. It is a very simple circuit but highly subjected to distortion.

WORKING PRINCIPLE :-



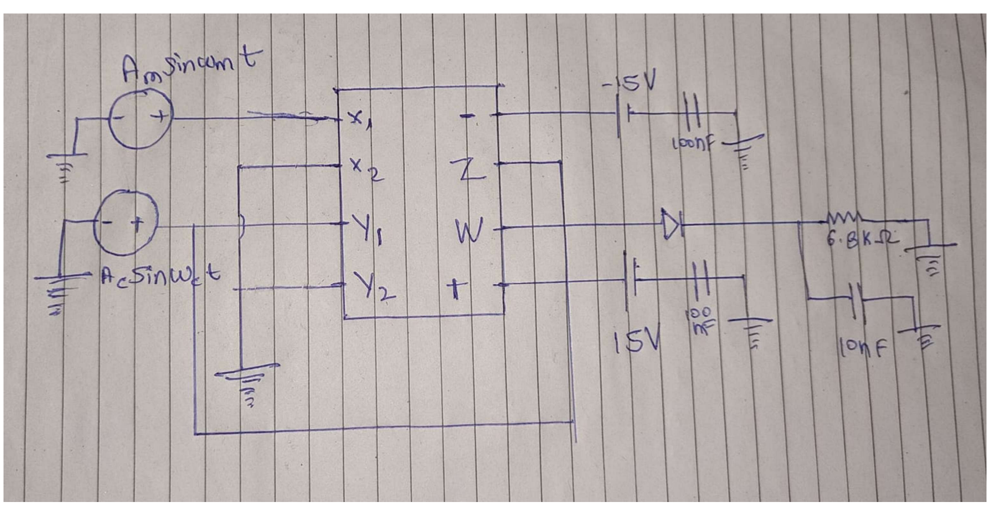
The AD 633 multiplier IC in the following way : (x1 – x2)*(y1 – y2)/10 + z where x1 = Am*sin(wm*t), x2 = 0, y1 = Ac*sin(wc*t), y2 = 0, z = Ac*sin(wc*t) and we obtain modulated signal at z.

For demodulation the capacitor gets charged and then slowly discharged through the resistor and thus the circuit is able to follow the message signal. RC constant of the filter should be chosen very carefully keeping in mind the frequency of message signal.

STEPS OF SIMULATION: -

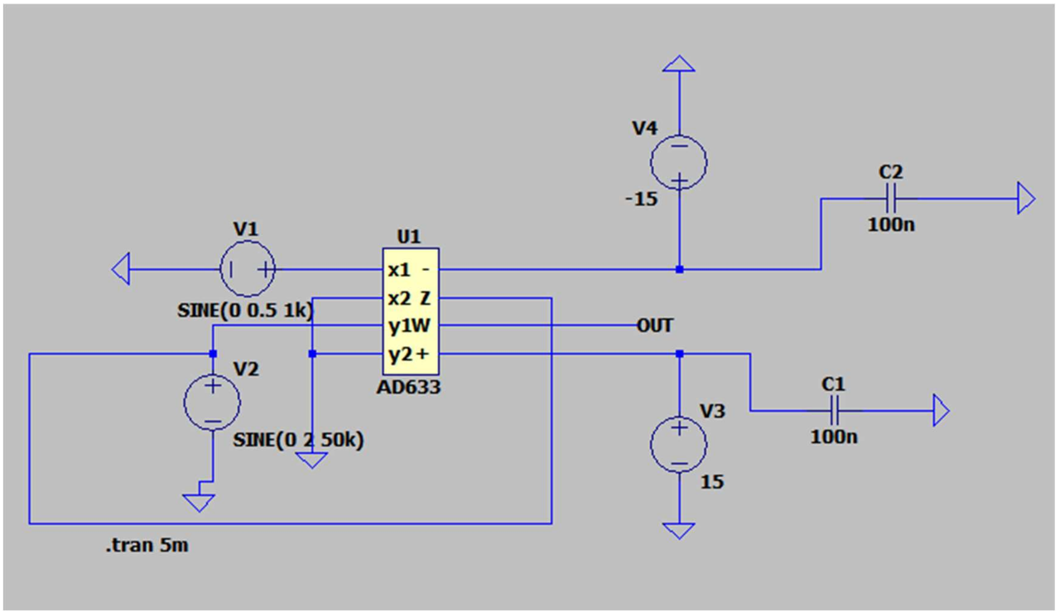
1. Design the modulator circuit in the simulator as shown in the figure below. Before that import the AD633 file and name the respective pins. Also configure the Gmin, Abstol and Reltol values in the control panel.
2. Assign proper values to the inputs and coupling capacitors and then click the run icon.
3. Obtain the output waveforms of pin w.
4. Change the peak-to-peak voltage of input signal to obtain modulated signal with different modulation indices.
5. Pass the modulated signal to the envelop detector circuit to obtain the scaled form of message signal.
6. To view the output in frequency domain, right click on the plot, view and then click FFT.
7. Change the scale from logarithmic to linear to obtain linear graph.

CIRCUIT DIAGRAM WITH DEMODULATOR: -

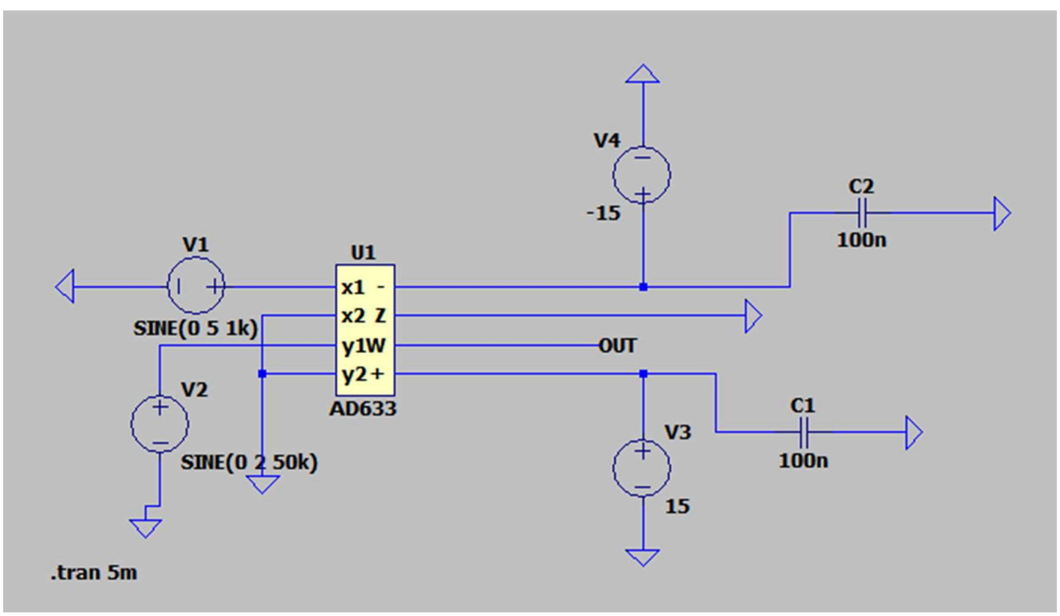


CIRCUIT DIAGRAMS: -

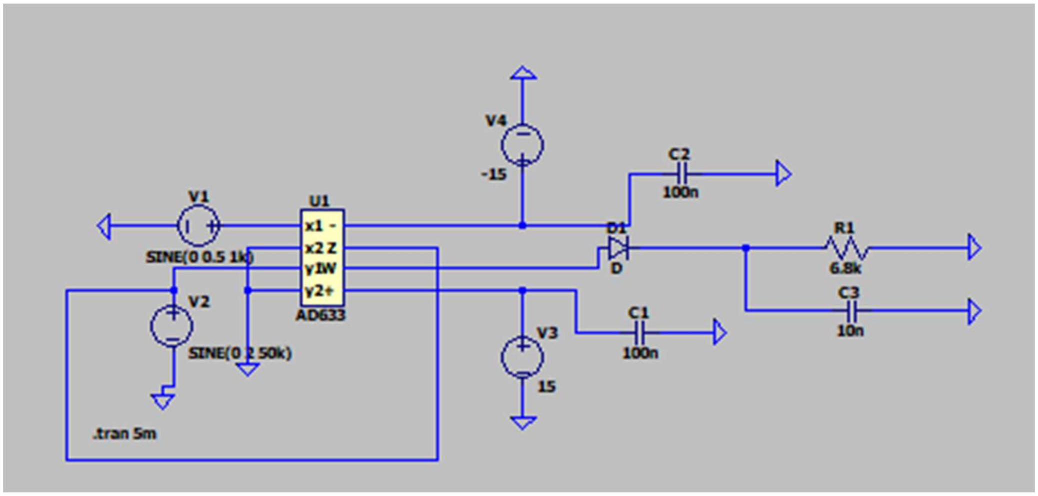
1. AM Modulation



2. AM Modulation with Z grounded



3. Demodulator with envelop detector circuit.



<u>OUTPUT WAVEFORMS, CALCULATIONS AND RESULTS</u>: -

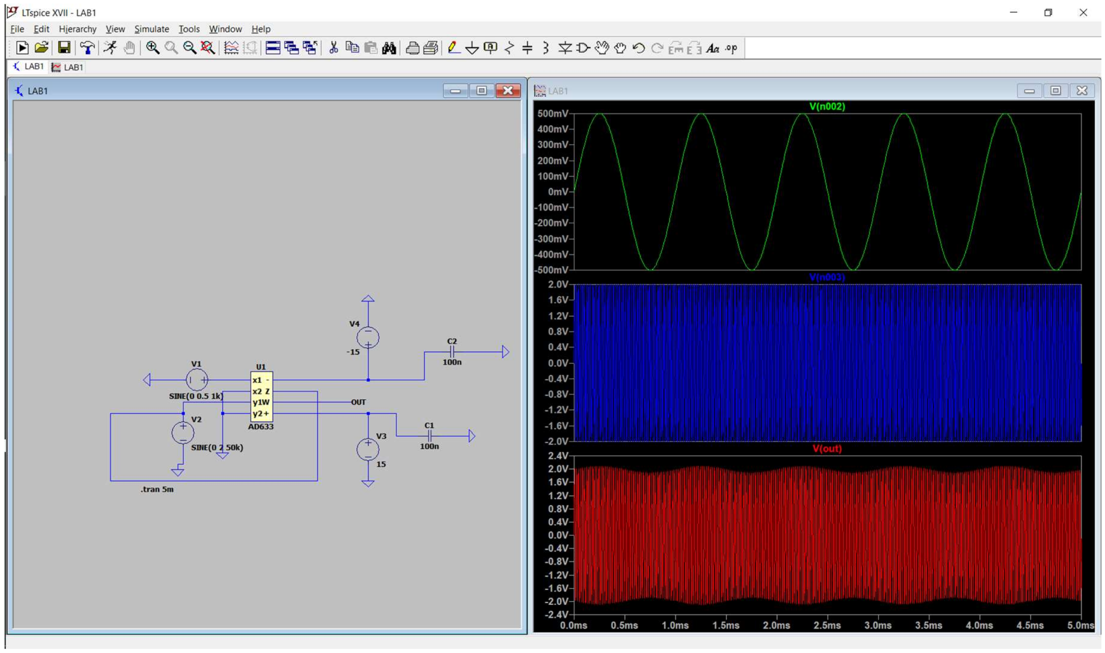
I have done modulation taking fc = 50 kHz and not 500 kHz as I was getting timestep error and was not able to obtain waveforms for a high frequency.

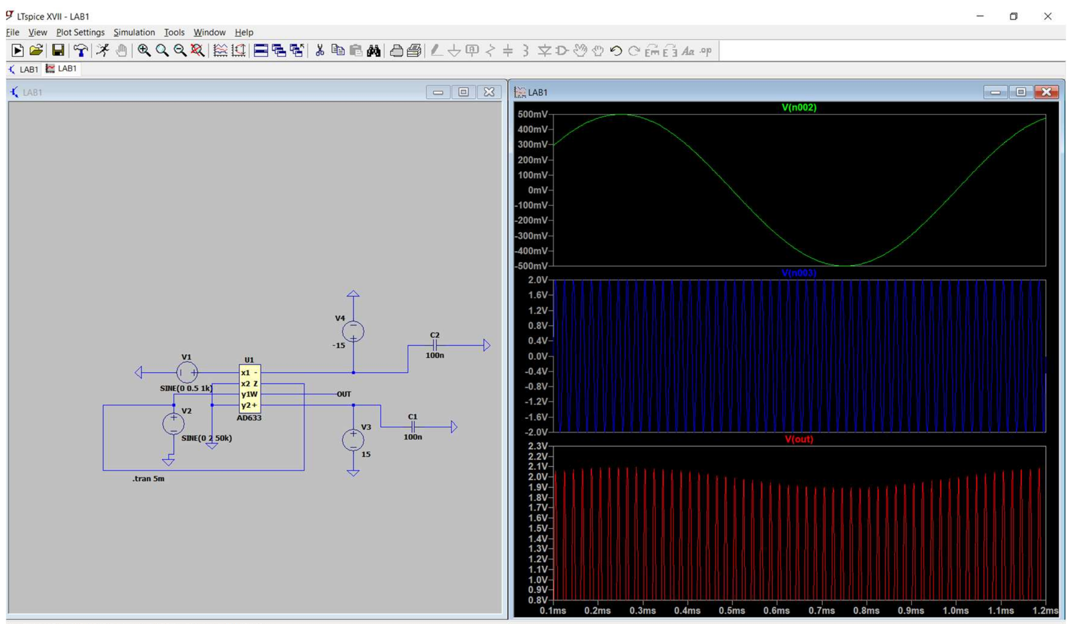
Modulation :-

1. Vp-p = 1 V (message signal)
   Vp-p = 4 V (Carrier Signal)
   fm = 1KHz
   fc = 50 kHz
   Amax = 2.09 V
   Amin = 1.881 V

   Theoretical Modulating Index = Vp-p/(10*2) = 1/(20) = 0.05

   Actual Modulating Index = (Amax – Amin)/(Amax + Amin) = 0.053

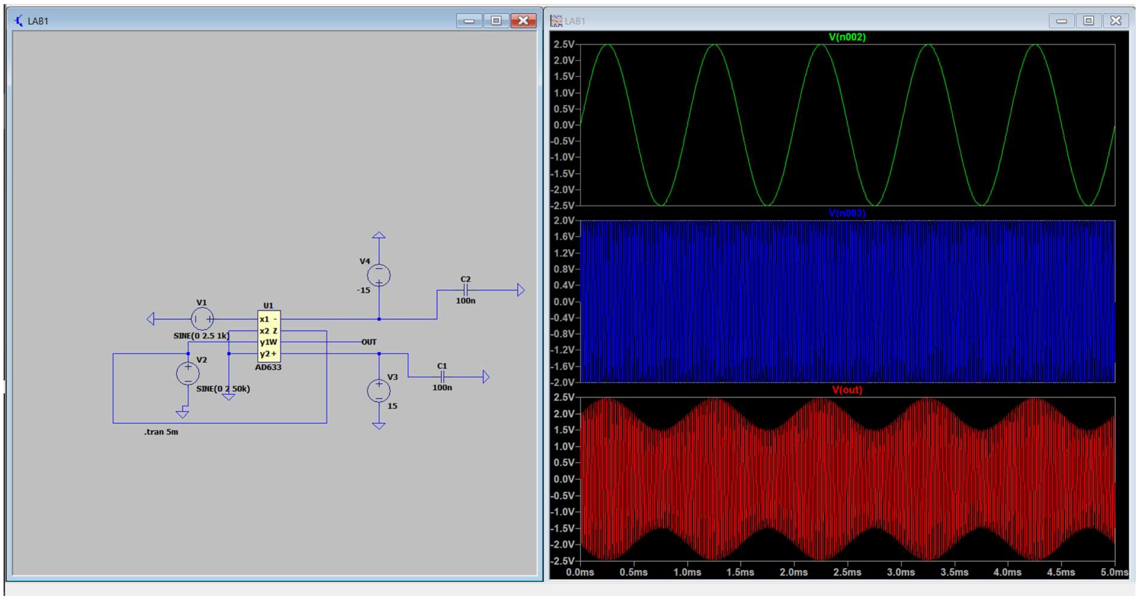


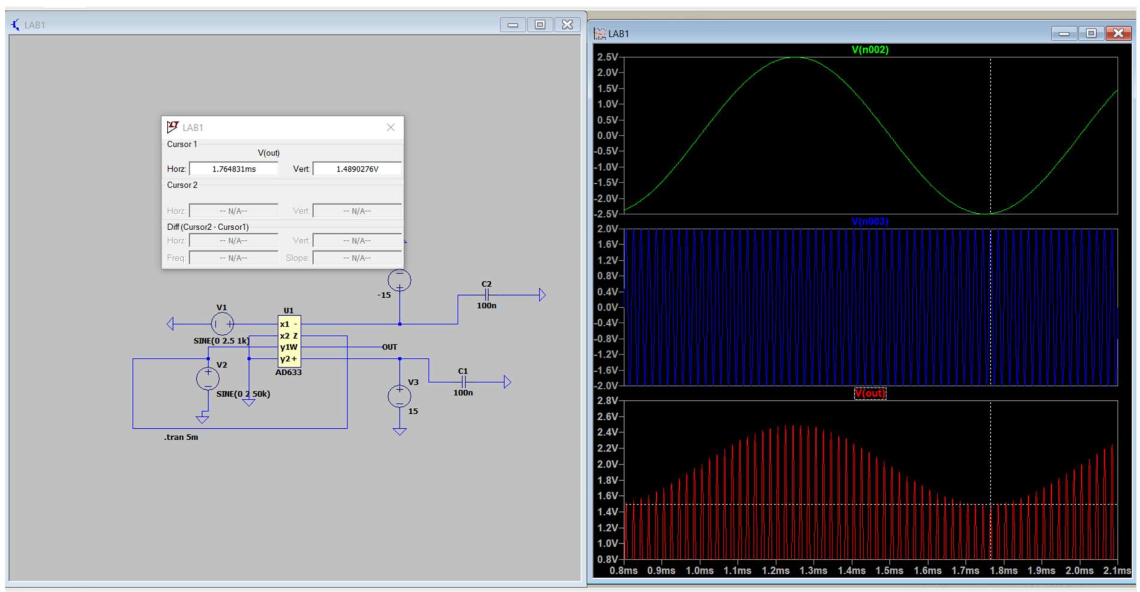


2. Vp-p = 5 V (message signal)
   Vp-p = 4 V (Carrier Signal)
   Fm = 1kHz
   fc = 50 kHz
   Amax = 2.49 V
   Amin = 1.489 V

   Theoretical Modulating Index = Vp-p/(10*2) = 5/(20) = 0.25

   Actual Modulating Index = (Amax – Amin)/(Amax + Amin) = 0.2515

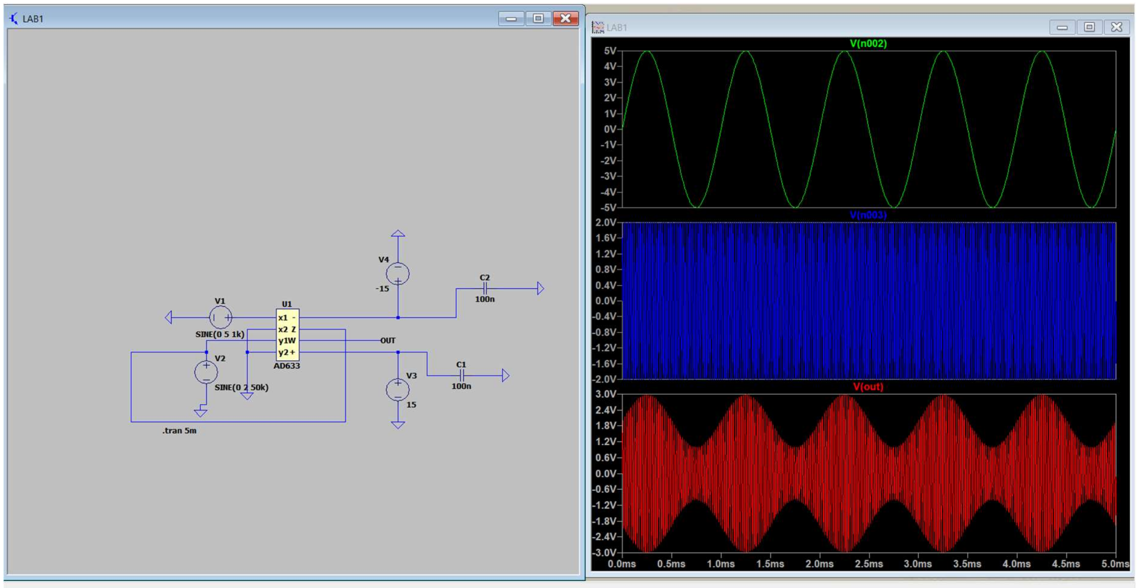


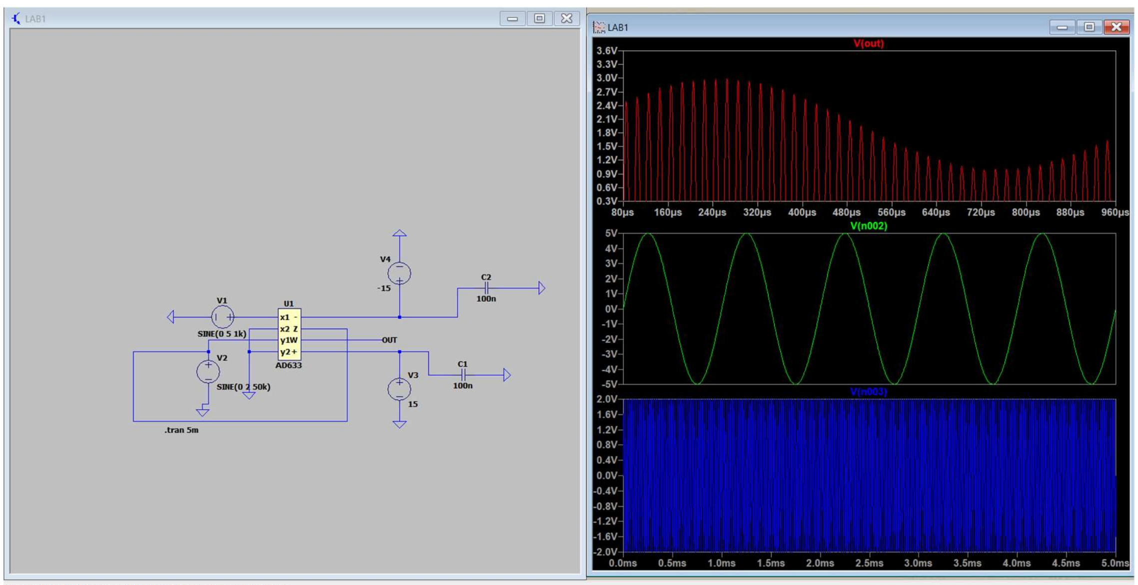


3. Vp-p = 10 V (message signal)
   Vp-p = 4 V (Carrier Signal)
   fm = 1 kHz
   fc = 50 k Hz
   Amax = 2.99 V
   Amin = 0.989 V

   Theoretical Modulating Index = Vp-p/(10*2) = 1/(20) = 0.50

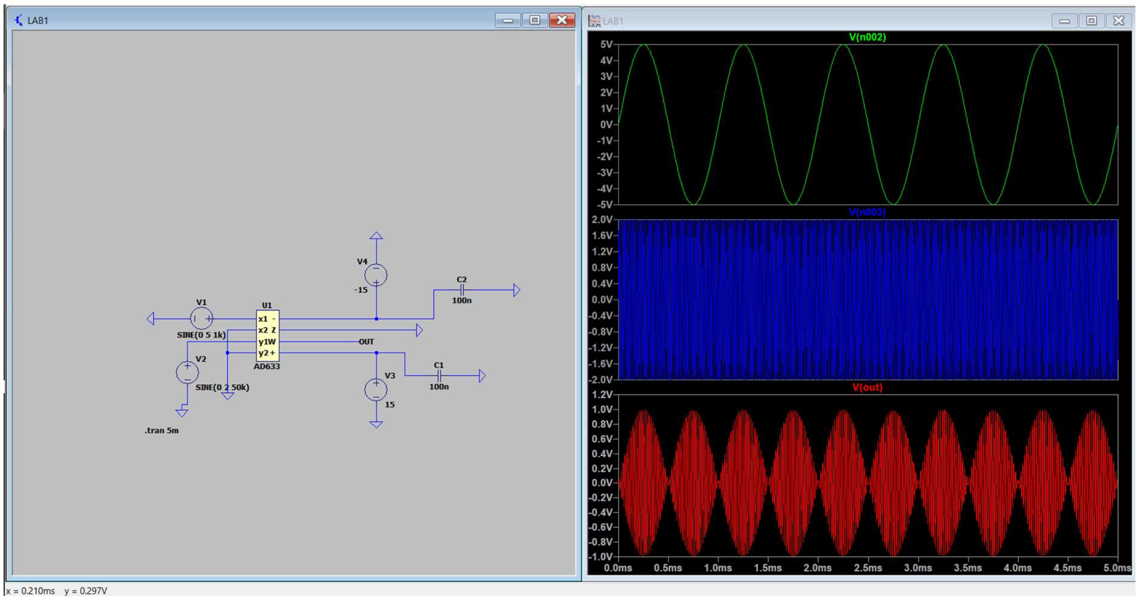
   Actual Modulating Index = (Amax – Amin)/(Amax + Amin) = 0.502

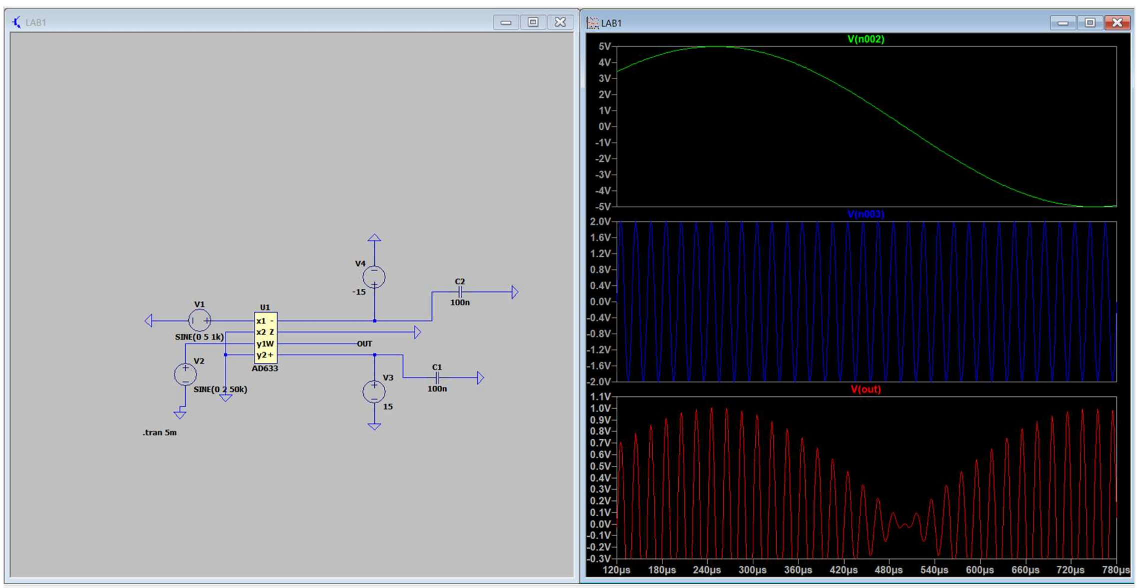




It is observed that modulation index of practical circuits is very close to the theoretical value.

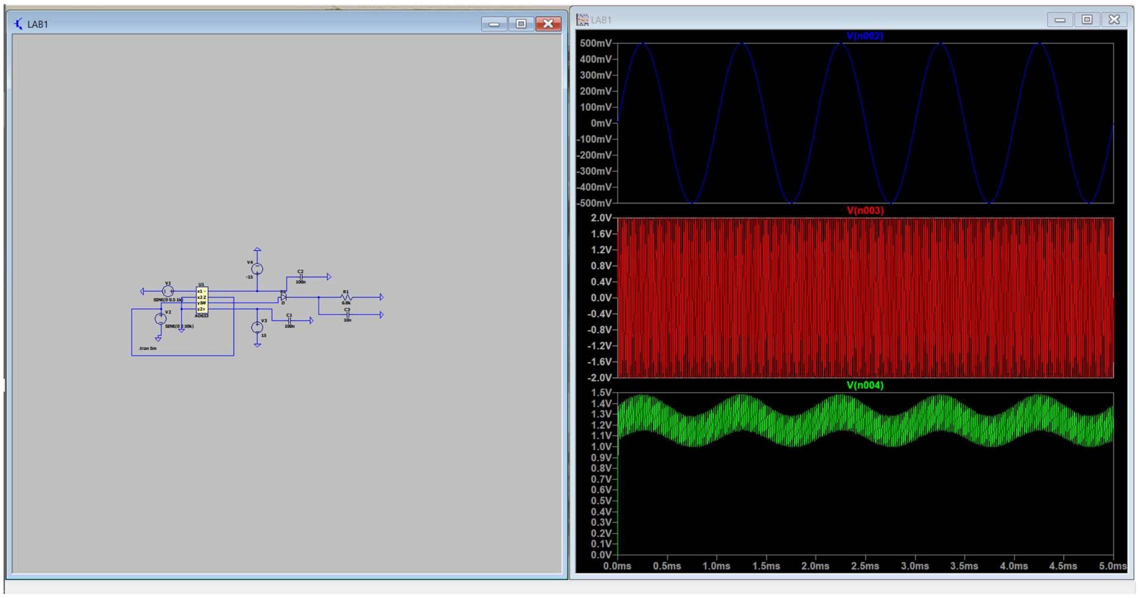
Modulation keeping Z grounded:-

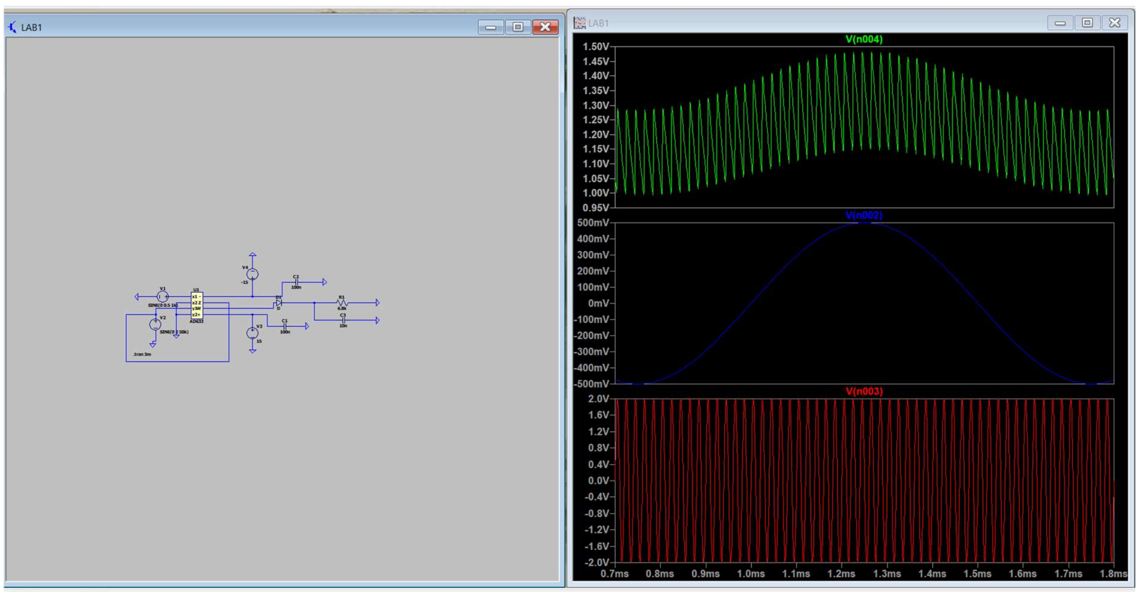




Phase reversal is observed in the modulated signal when Z was grounded.

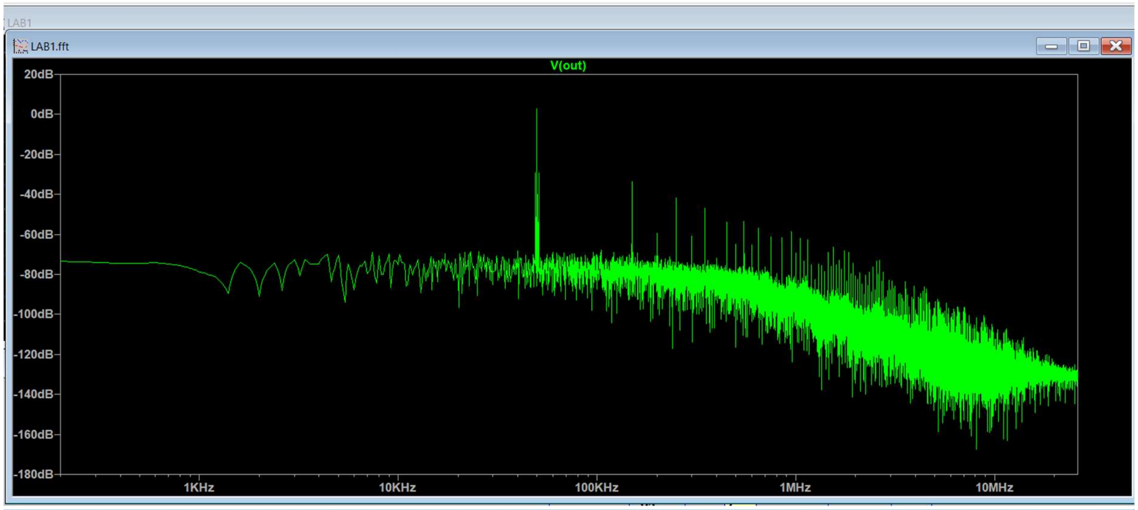
Demodulation: -

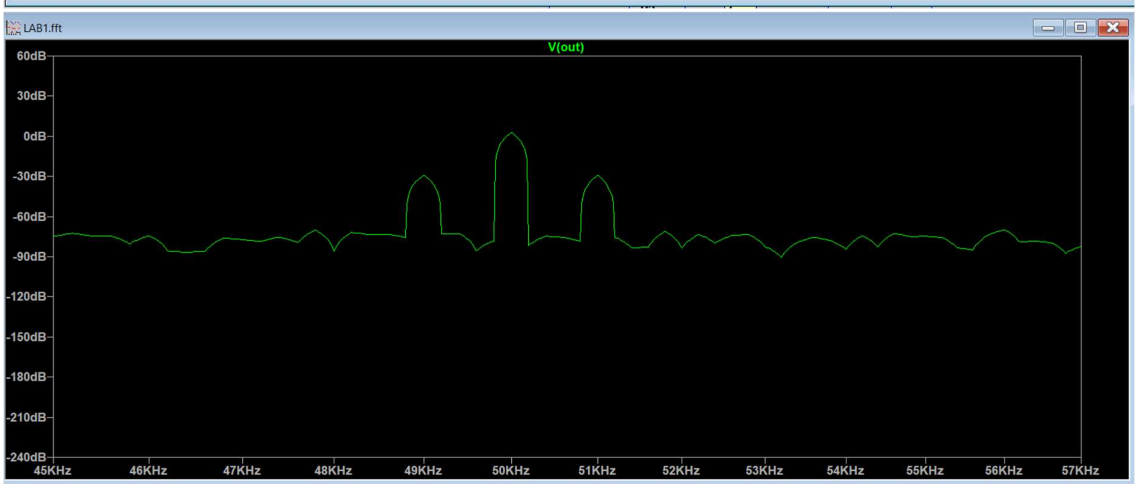




I was successfully able to obtain the scaled form of the message signal after demodulating through a envelop detector circuit.

Output in Frequency Domain :-





Peaks are observed at 49 kHz, 50 kHz and 51 kHz. Also, very high frequency noise components are observed in the modulated signal.

Thank You!