EE 321 Lab Report

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EXPERIMENT - 1

AIM :-

1. Generation of DSB-SC AM Modulated signal using diode-based switching modulator circuit.
2. Demodulation of AM modulated signals using envelop detector circuit.

THEOROTICAL BACKGROUND: -

DSB-SC is an AM modulation in which frequencies are symmetrically placed around the carrier frequency and carrier level gets reduced to lowest practical level. It is obtained by simply multiplying carrier signal with the message signal and hence can be easily obtained by suing a product modulator.

Let the modulating signal be,

$$m(t) = Am\cos(2\pi fmt)$$

and the carrier signal be,

$$c(t) = Ac\cos(2\pi fct)$$

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

$u(t) = Acm(t)\cos(2\pi fct)$

DSB-SC goes to 0 when message signal goes to 0 and

has a phase reversal when message signal changes sign.

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.

<u>WORKING PRINCIPLE</u> :-

We obtain the DSB-SC signals using the product modulator. When all diodes are off, amplitude of message is obtained at output and when all diodes are on 0 is obtained at output. Due to this switching the message signal gets multiplied with a square wave of frequency fc and using forear series we can see this signal contains odd harmonics. So we pass this signal through a band pass filter with center frequency fc to obtain the modulated signal. We also give Dc offset to make message signal >0 to prevent phase change of modulated signal and thus making demodulation easier.

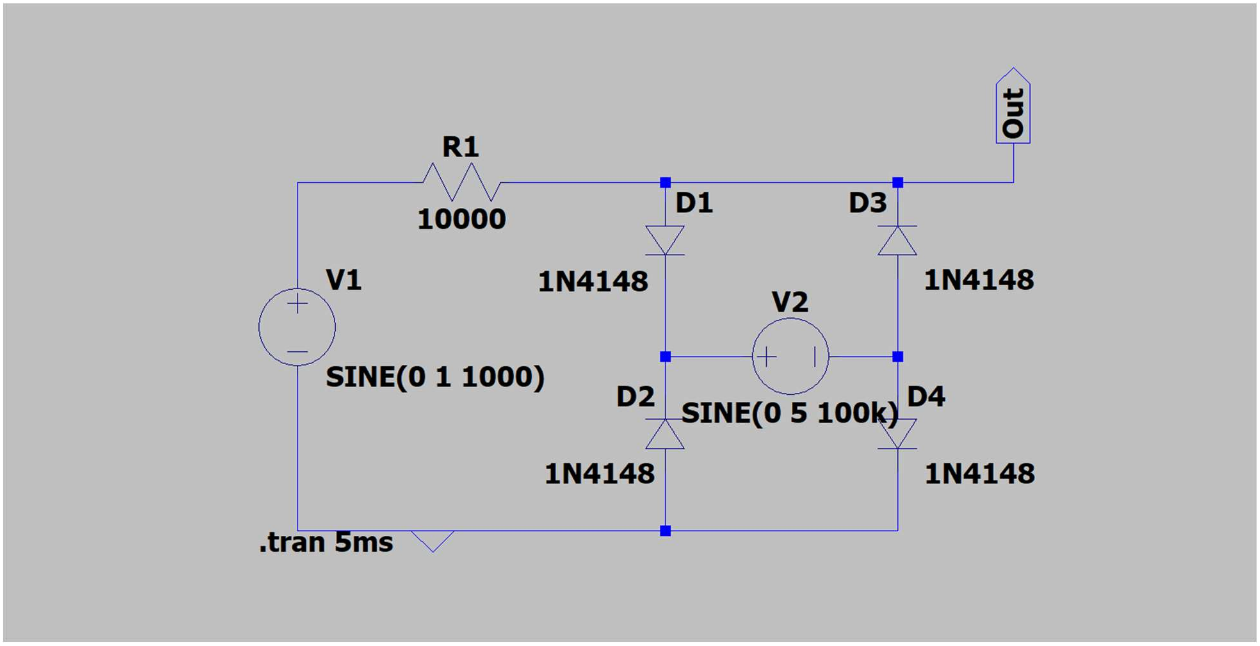
During demodulation the capacitor gets charged and then slowly discharged through the resistor and thus the circuit is able to follow the message signal. RC constant of the filter should be chosen very carefully keeping in mind the frequency of message signal.

<u>STEPS OF SIMULATION</u>: -

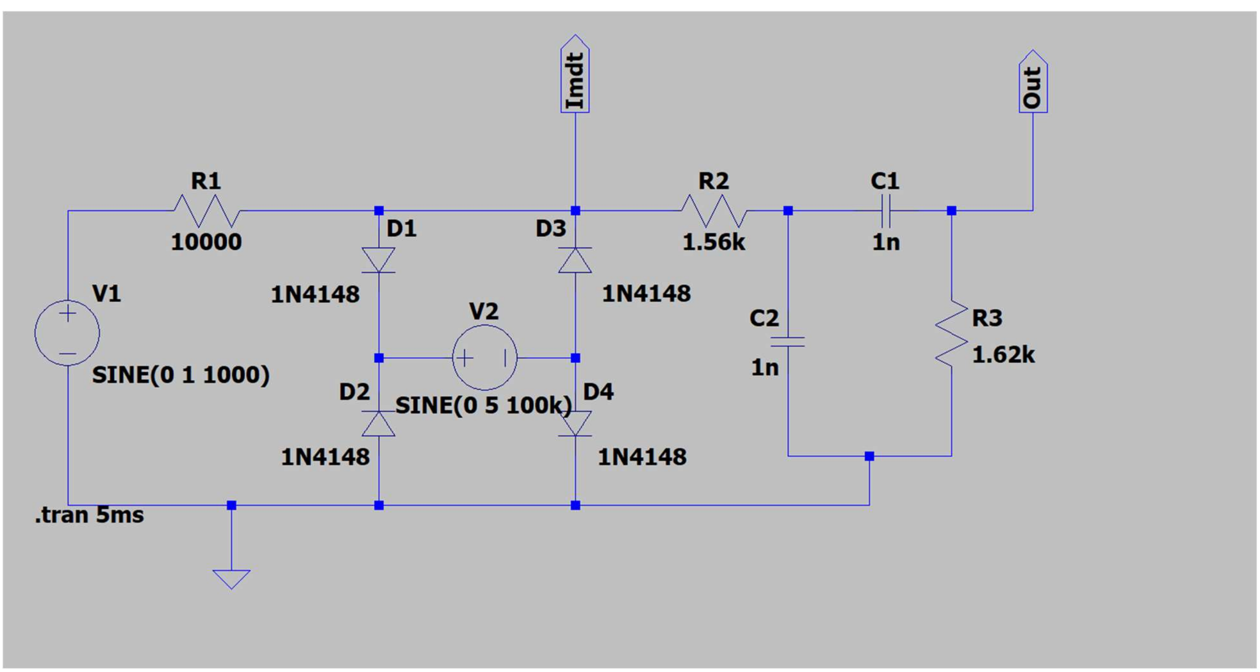
1. Assemble the circuit as shown below and apply the appropriate signals and observe the output.
2. Pass this output through a band pass filter to get the modulated signal and observe phase sift in it.
3. Now give a suitable dc offset to the message signal so that it always remains positive and then observe the modulated signal.
4. Design the envelop detector circuit as shown and pass the modulated signal to get the message signal back.
5. Now view the FFT graph and change the scale from logarithmic to linear to obtain linear graph to view the output frequency domain.

CIRCUIT DIAGRAMS: -

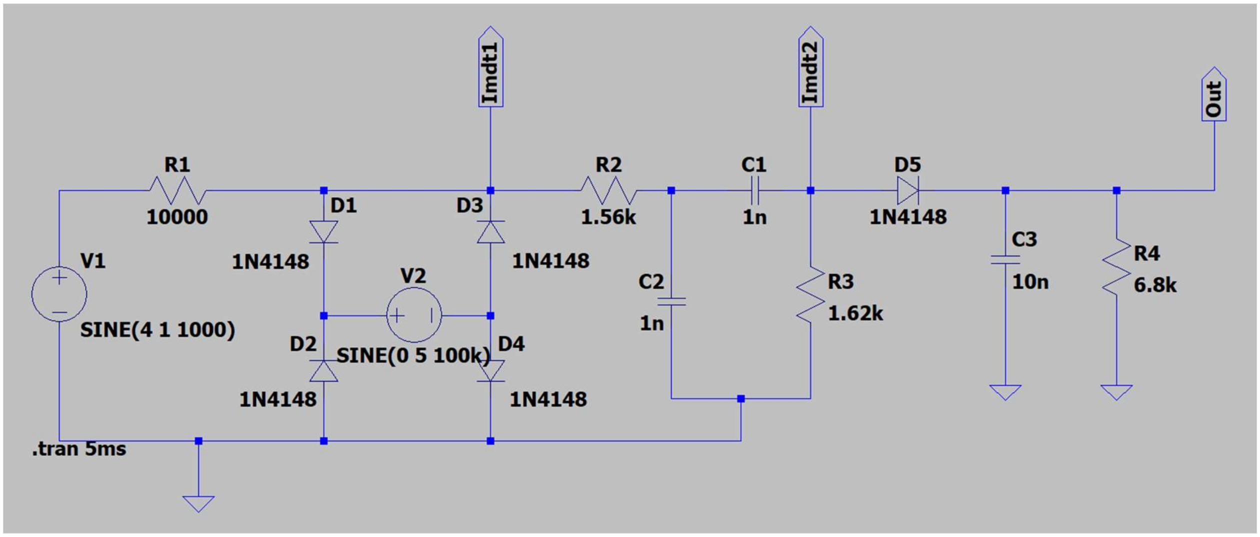
1. Generating DSB-SC signals.



2. DSB-SC signals with band pass filter.



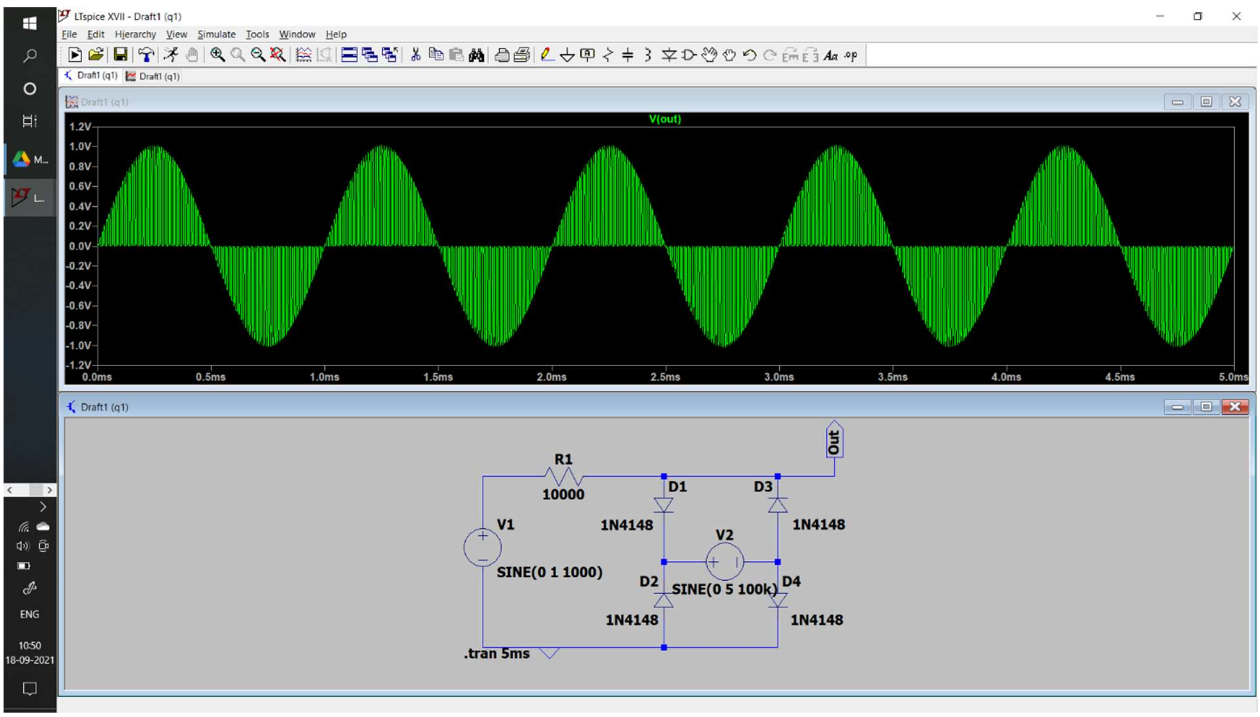
3. DSB-SC Signal generator with Demodulator

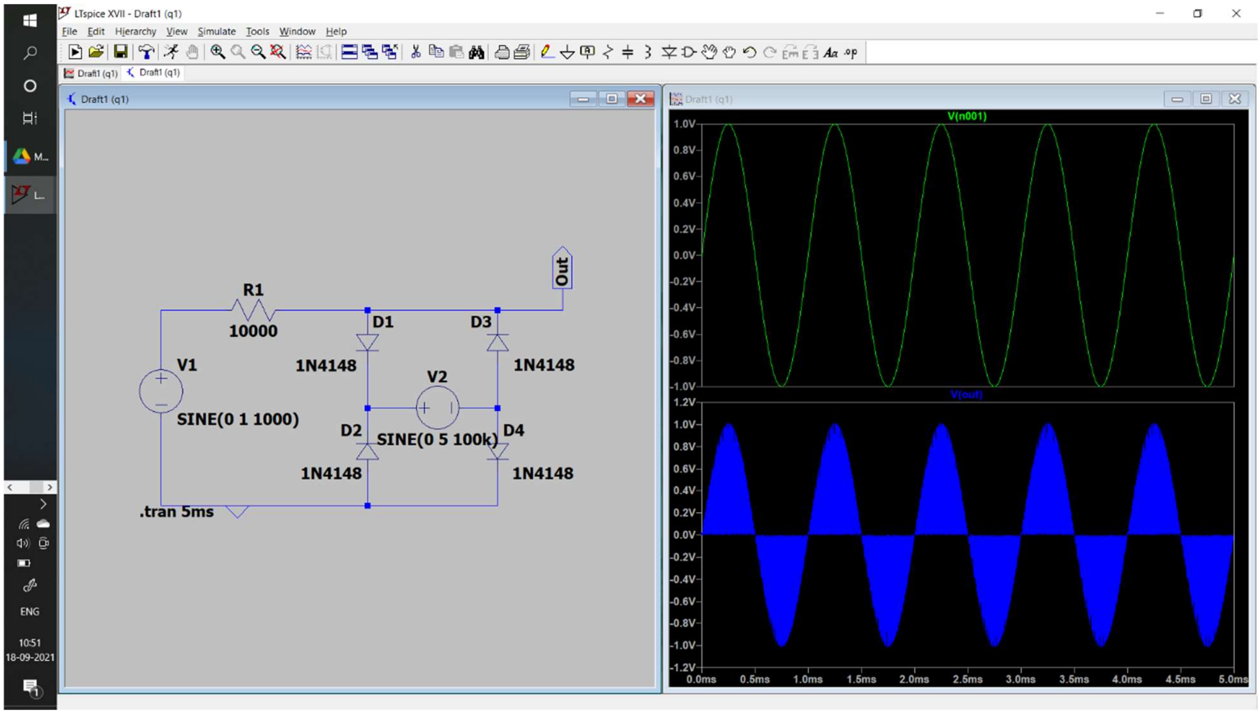


<u>OUTPUT WAVEFORMS, CALCULATIONS AND RESULTS</u>: -

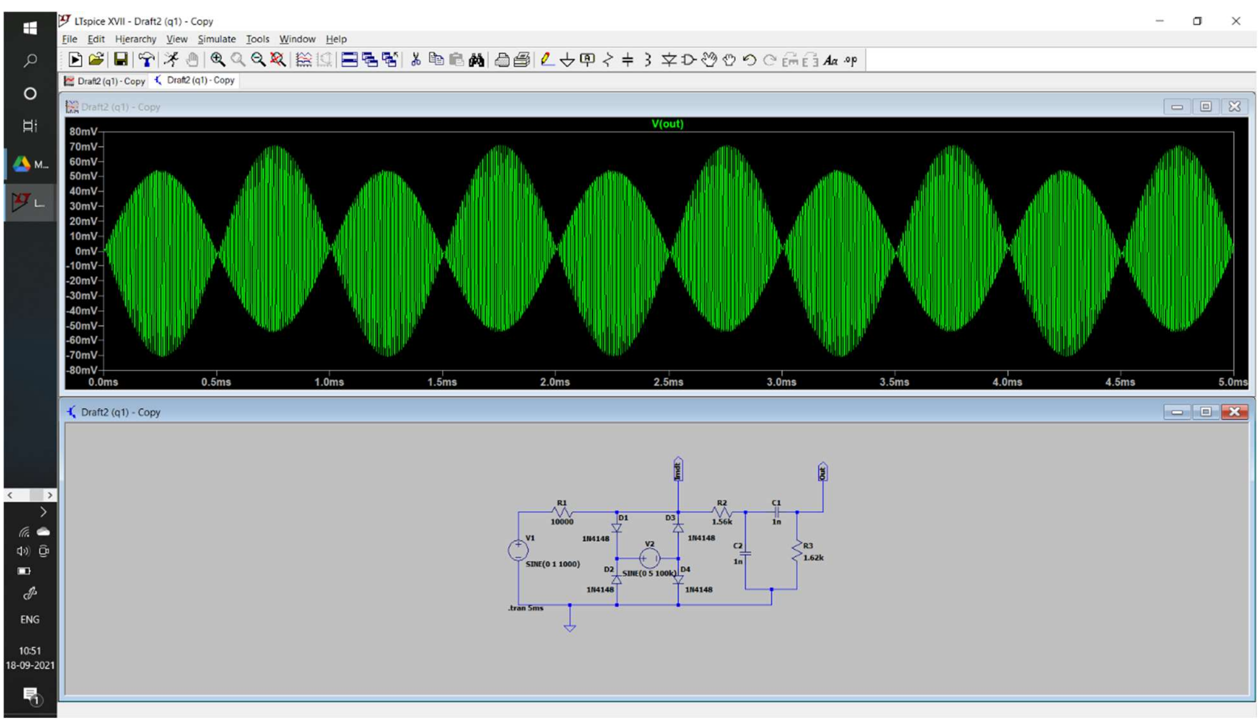
I have done modulation taking fc = 50 kHz and not 500 kHz as I was getting timestep error and was not able to obtain waveforms for a high frequency.

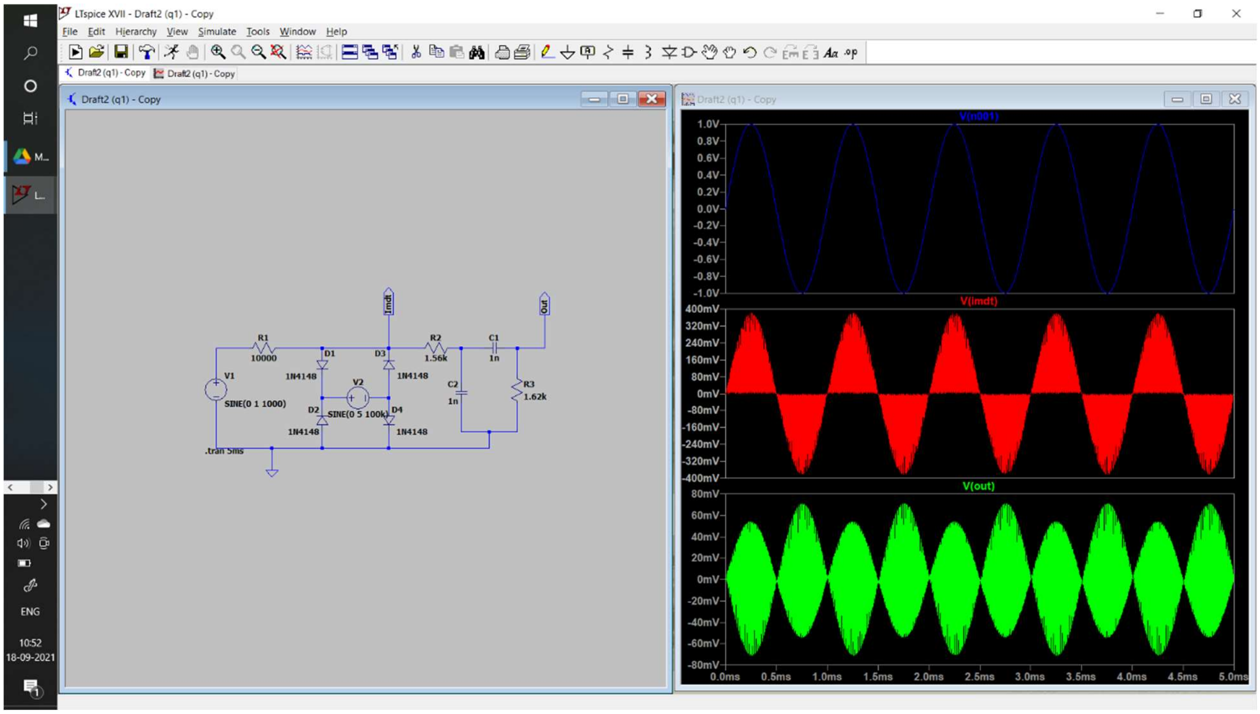
1. Output of diode switching circuit



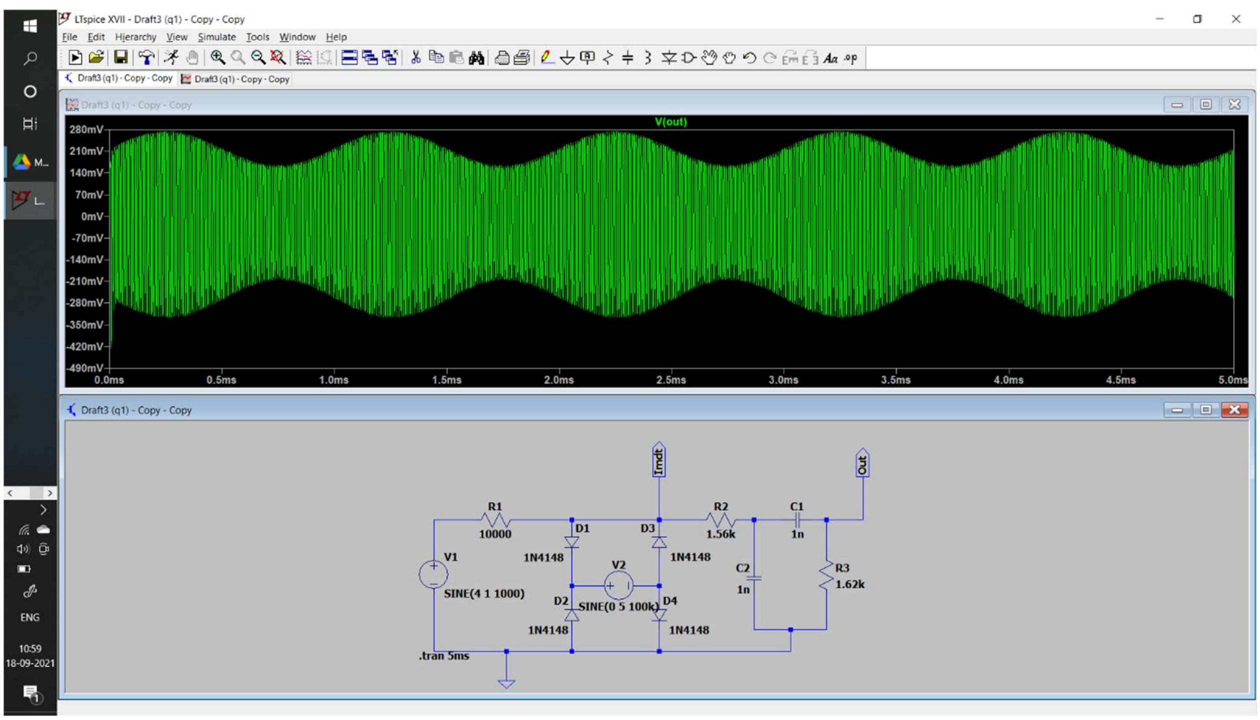


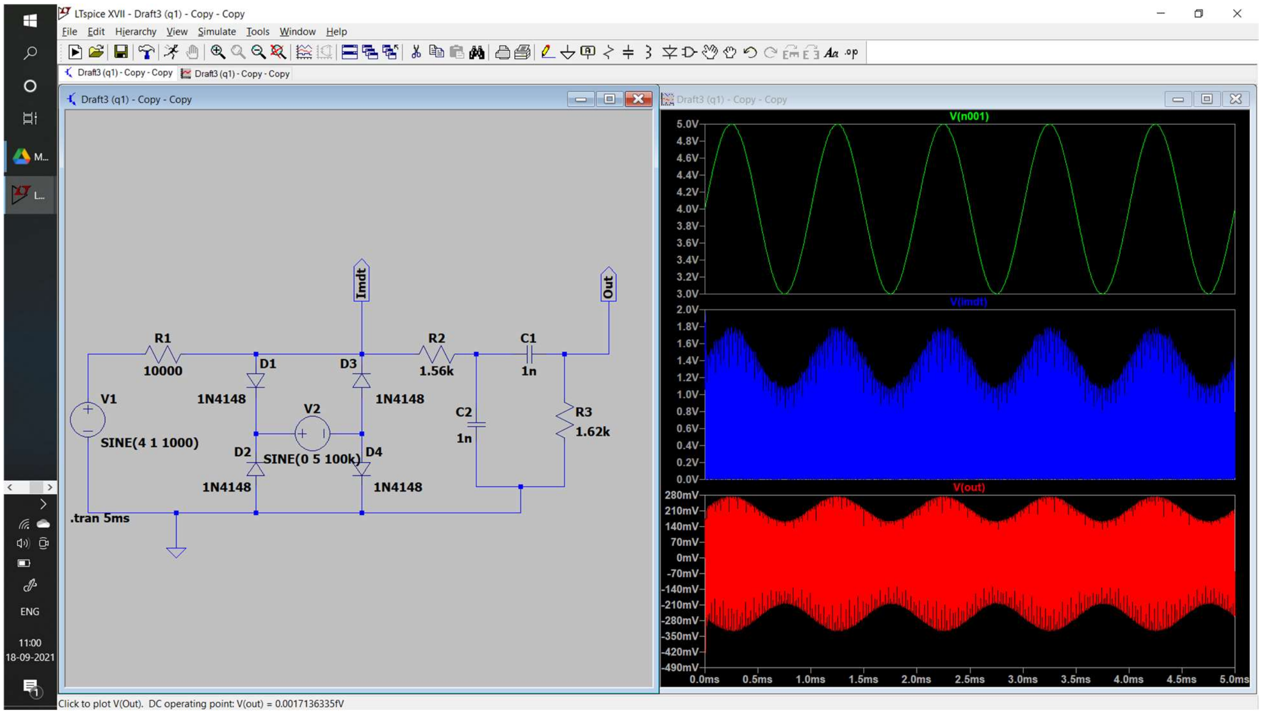
2. Outuput of diode switching circuit with band pass filter





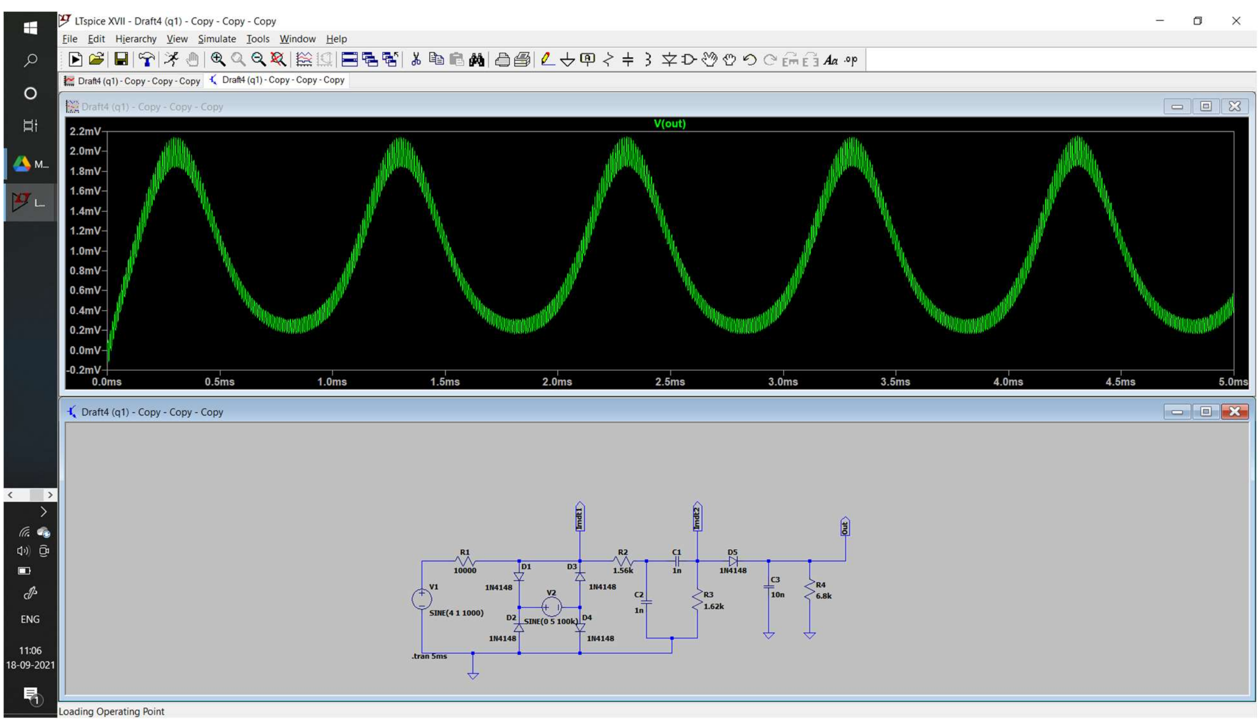
3. DSB-SC signal when input has dc offset of 4 volts.

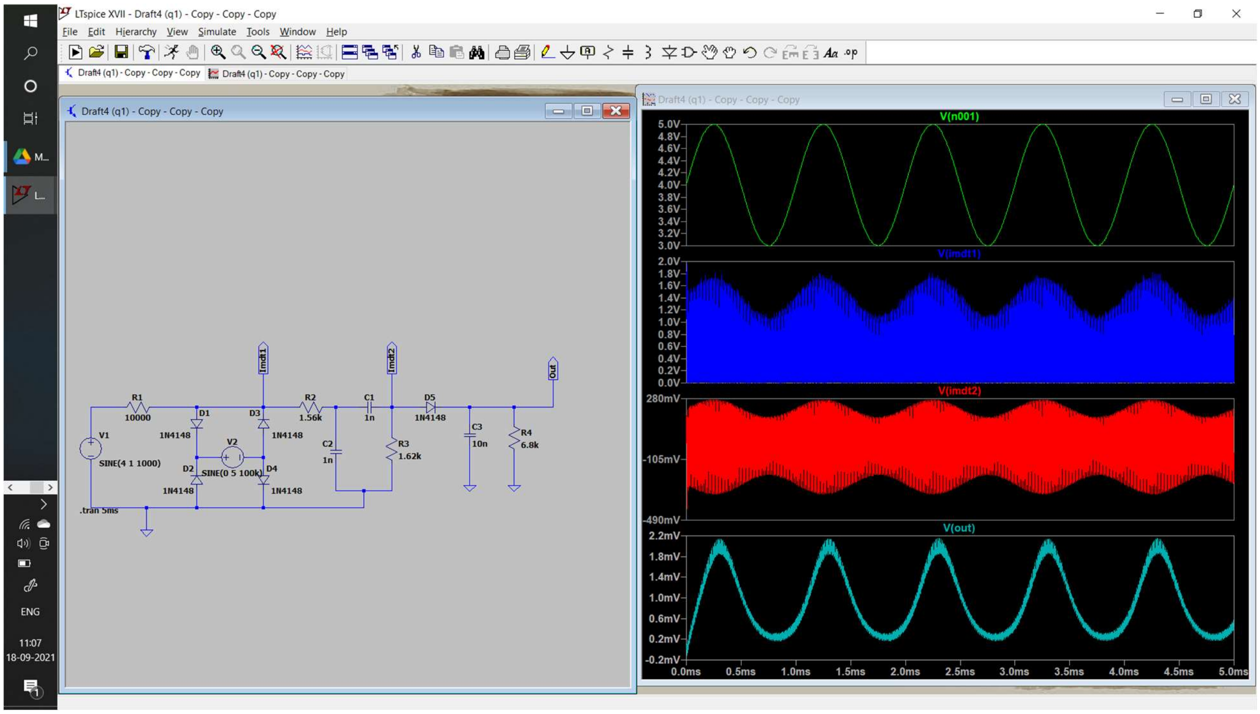




4. Demodulation of DSB-SC signal

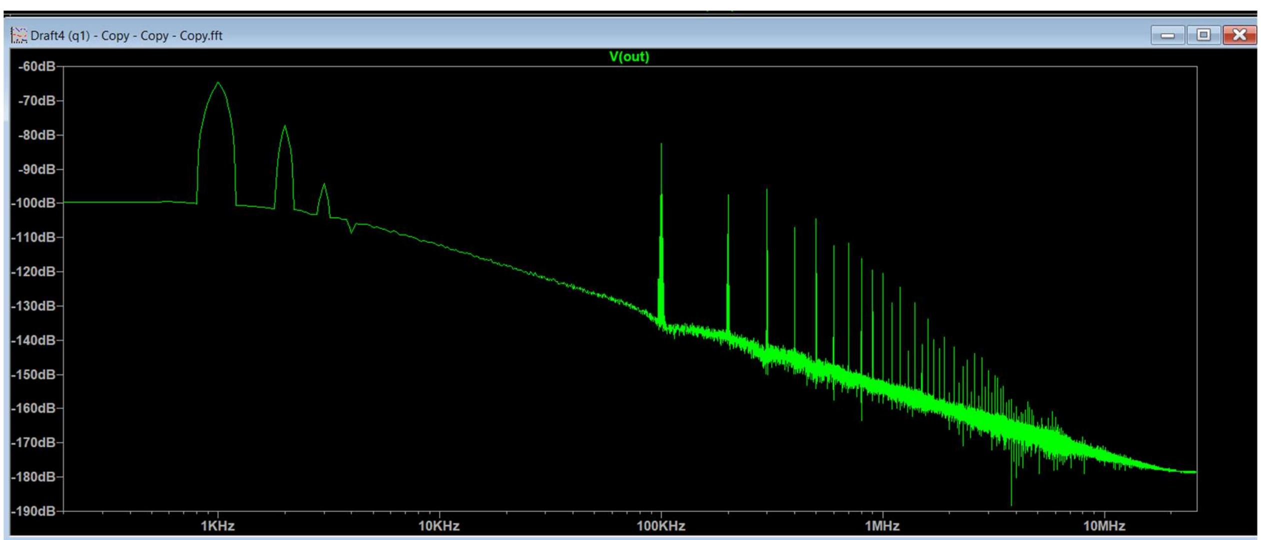
I was successfully able to obtain the scaled form of the message signal after demodulating through aenvelop detector circuit.

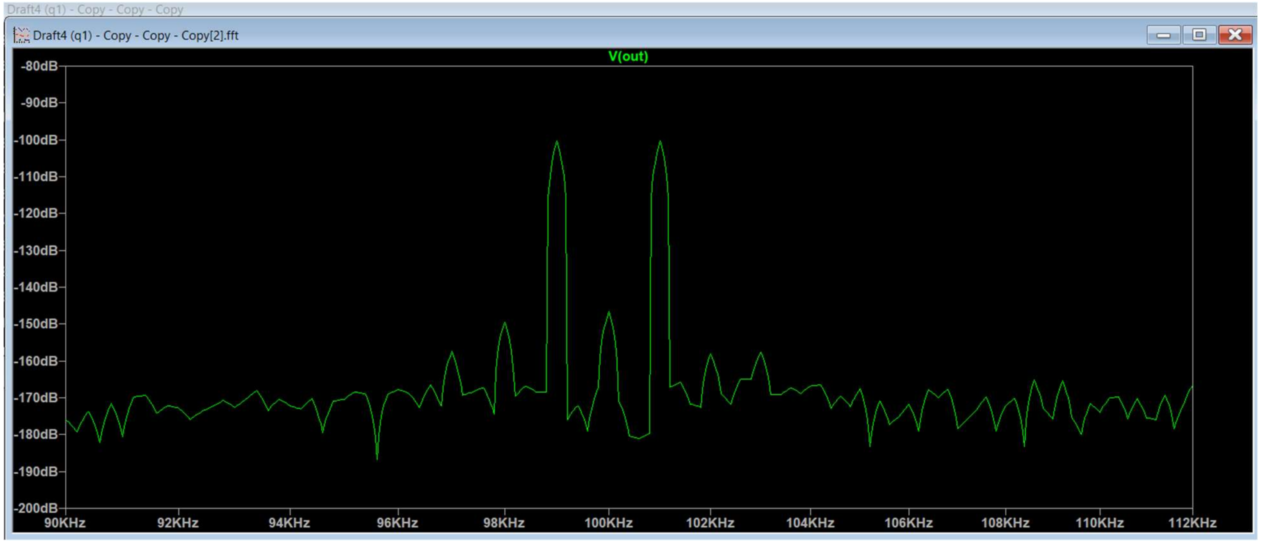


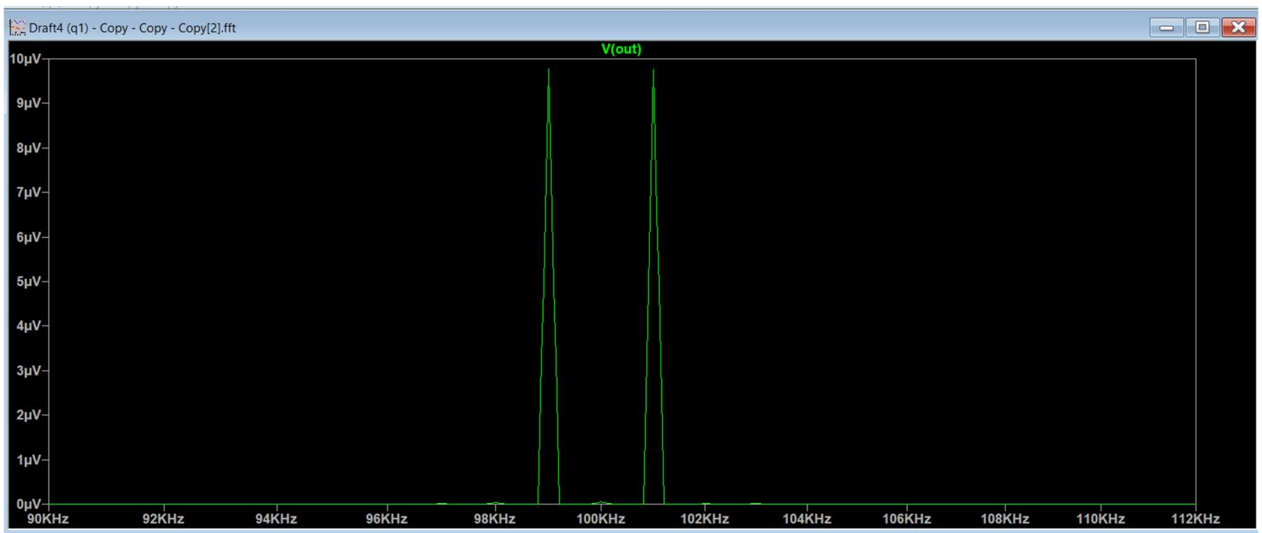


Output in Frequency Domain :-

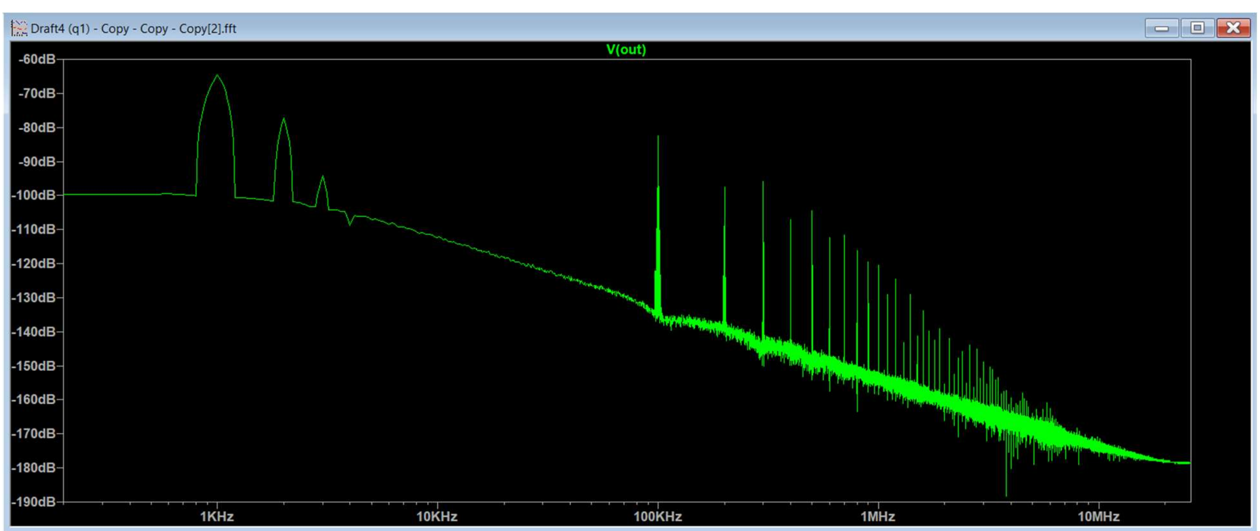
1. Input without DC offset

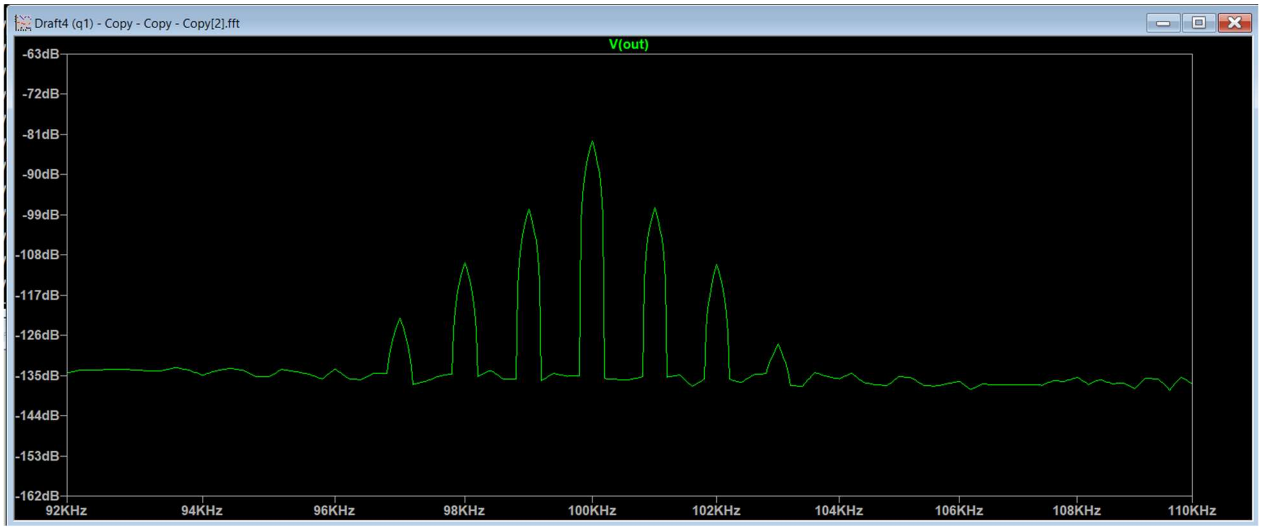


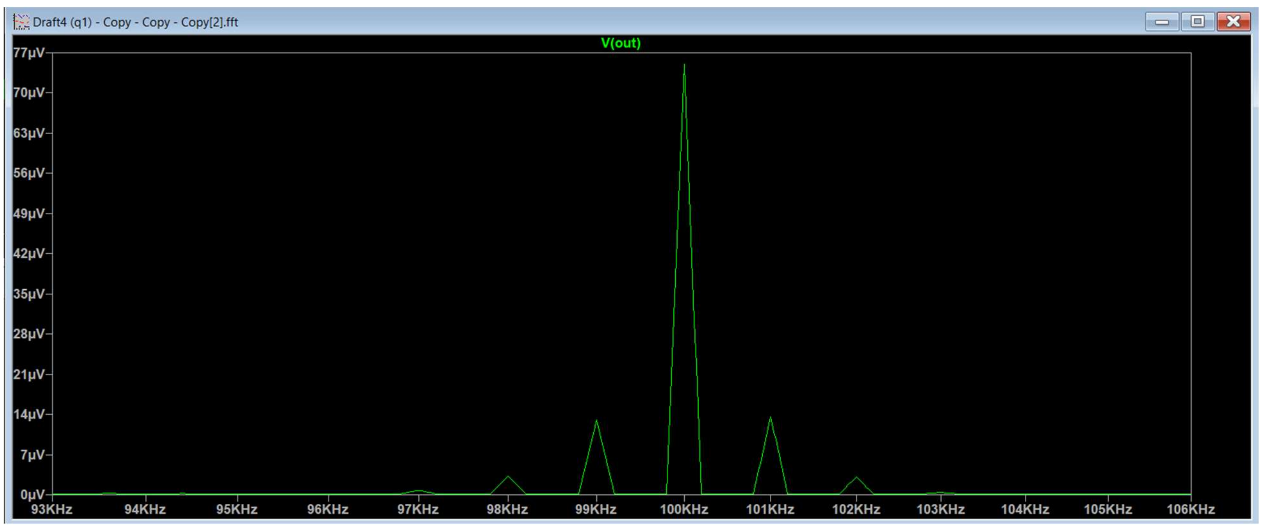




2. When input has DC offset







Peaks are observed at 99 kHz, 101 kHz. When there is no DC offset given the carrier is suppressed but when DC offset is given, carrier frequency is also observed in the frequency domain. Also, very high frequency noise components areobserved in the modulated signal.

<u>Answers of Lab Questions: -</u>

A1. Without DC offset the output is distorted and as we know that when the message signal goes to 0, DSB-SC goes to 0 so it becomes very difficult to demodulate the signal and hence we get distorted in output signal. But with DC offset overall message signal never goes to 0 and hence it becomes easy to demodulate the signal.

A2. Modulation index tells us the extent to which the modulation is done. In AM modulation it is defined as the ratio of amplitude of message signal to the amplitude of carrier signal. It can also be expressed as (Amax – Amin)/(Amax + Amin) if we see wrt to modulated signal.

Modulation Index without DC offset : -

Amax = 70.51 mV
Amin = 1.07 mV
So modulation index = 0.97

Modulation Index with DC offset: -

Amax = 273.59 mV
Amin = 163.68 mV
So modulation index = 0.2513

A significant difference is observed in the modulation index when we give DC offset to the input signal.

A3. According to the first circuit diagram when voltage between D1 and D2 is more than that of D3 and D4, all diodes are in reverse bias and thus are turned off so amplitude of message signal will be the output. In the opposite case all the diodes will be turned on and hence 0 output will be obtained. This switching multiplies the message signal with a square wave of carrier frequency fc.

A4. Experiment was easy to do except for the point when we apply DC offset, carrier frequency is observed in the frequency domain. Also deciding the values of R and C for the RC filter was difficult.

Thank you!