LAB Experiment 6
Wave shaping Circuits

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October 25,2020

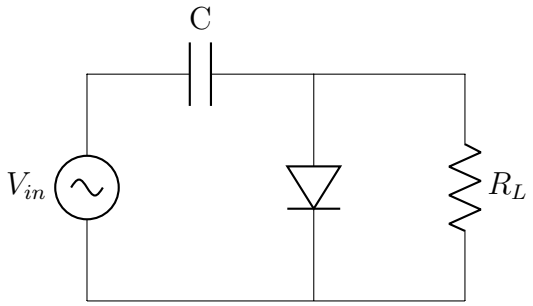
1 Aim

- Write a SPICE script for negative clamper circuit.
- Design clipper circuit (and write SPICE script) such that The maximum voltage in the positive half cycle is $+2V_\gamma$ and the minimum voltage in negative half is -$3V_\gamma$.
- Given Inputs
  - V_{in_peak} = 5 V
  - Frequency = 1k Hz
  - R = 100 Ω(Clipper Circuit)

2 Procedure

2.1 Negative clamper

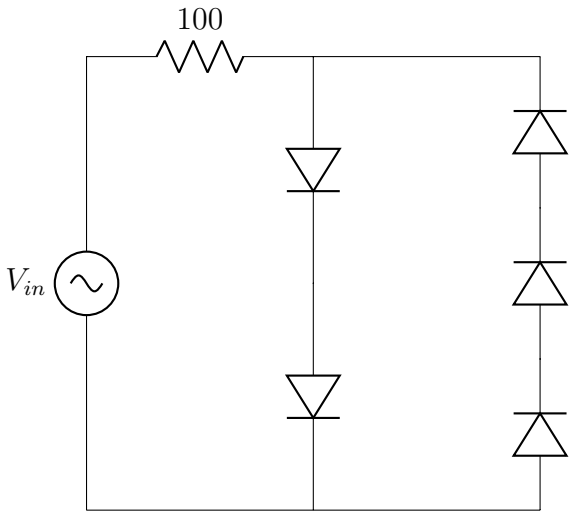
The circuit for negative clamper circuit is given below along with the values of the components.



Let the values of C be $10\mu F$ and R_L be $10k\Omega$ and the input signal be a sin wave with V_{in_peak} = 5 V and Frequency = 1k Hz.

2.2 Clipper

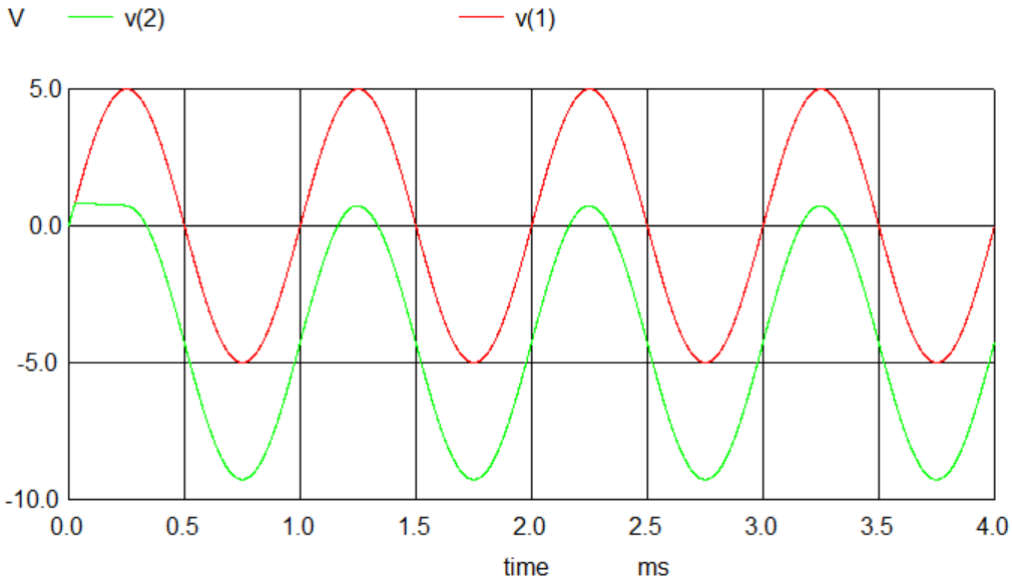
The negative clipper circuit for the given specifications can be constructed as the below circuit.



Let the value of R be 100Ω and the input signal be a sin wave with $V_{in_{peak}} = 5$ V and Frequency = 1k Hz.
Write the NGspice scripts for the above circuits accordingly with the given component values and plot the input and output graphs.

3 Results and Understanding

3.1 Negative clamper



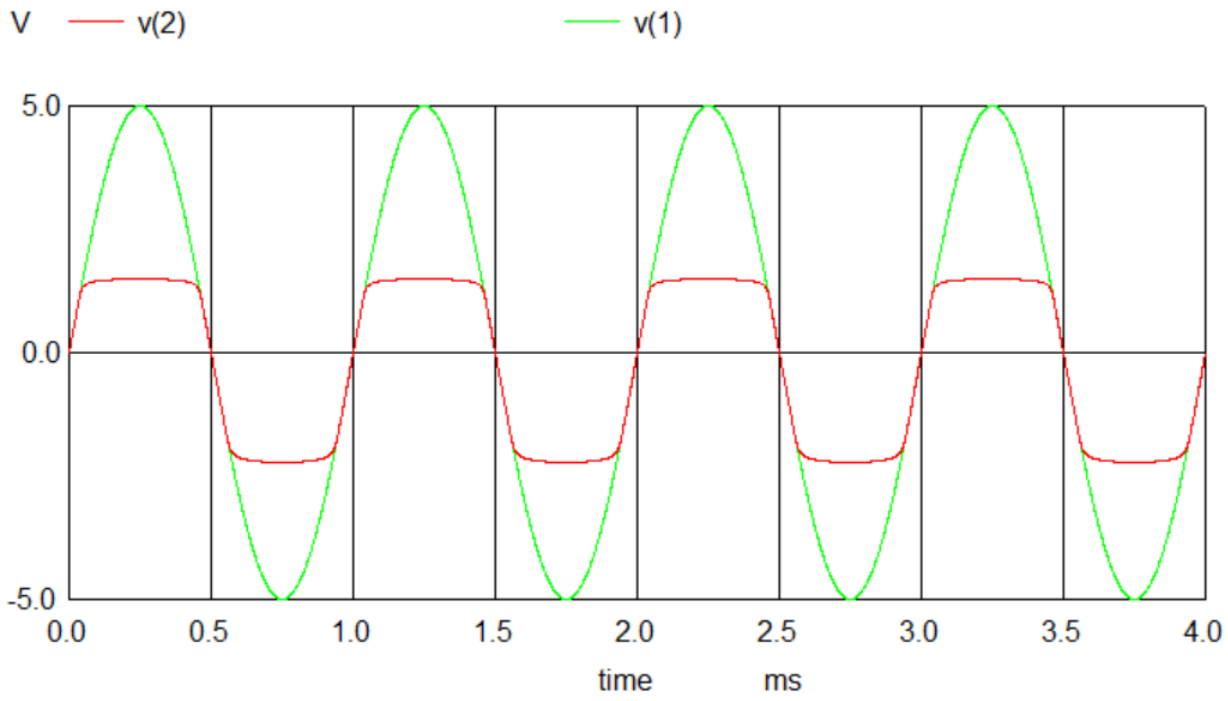
The above graph can be understood as follows -

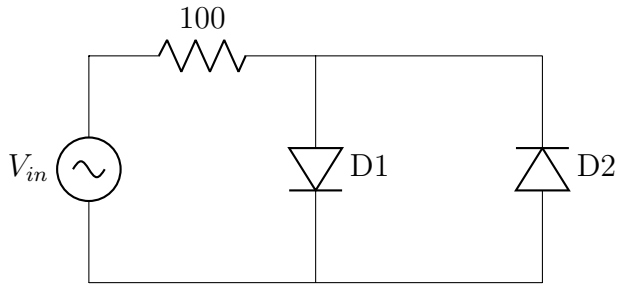
- During the positive half cycle of the input AC signal, the diode is forward biased so current flows through it and hence no signal appears at the output.And due to the diode conduction voltage(V_γ) the output voltage is clipped at V_γ.
  Also the capacitor is charged to $V_C = (V_{in_{peak}} - V_\gamma)$.

- During the negative half cycle of the input AC signal, the diode is reverse biased and hence the signal appears at the output and no current flows through the diode.
  Due to the high value of R_L the time constant of the circuit is high compared to the time period of the signal, so the capacitor is not discharged and the output voltage will be $V_{in} - V_C = V_{in} - (V_{in_{peak}} - V_\gamma)$ and the peak of the negative half of output is $-(2V_{in_{peak}} - V_\gamma)$.

- During the next positive half cycle of input, the output voltage will be $V_{in} - V_C = V_{in} - (V_{in_{peak}} - V_\gamma)$ since the capacitor is not discharged and the peak of the positive half of output is $V_{in_{peak}} - (V_{in_{peak}} - V_\gamma) = V_\gamma$.

3.2 Clipper





- If we connect the diodes as shown above, then both the positive and negative half cycles would be clipped as diode D1 clips the positive half cycle of the sinusoidal input waveform while diode D2 clips the negative half cycle.
- For ideal diodes the output waveform above would be zero. But due to the diode conduction voltage($V_\gamma \approx 0.7V$) ,the actual clipping point occurs at $+V_\gamma$ and $-V_\gamma$ respectively. But we can increase this $\pm V_\gamma$ threshold by connecting together more diodes in series creating multiples of V_γ.
- Since we need the maximum voltage in the positive half cycle to be $+2V_\gamma$ and the minimum voltage in negative half to be -$3V_\gamma$, we connect 2 diodes in series as forward biased and 3 diodes in series as negative biased as shown in the circuit diagram in procedure.

4 Conclusion

We already discussed linear wave shaping circuits like filters in previous experiments where elements such as resistors, capacitors and inductors are employed to attenuate the unwanted signal or to reproduce the selected portions of the frequency components of a particular signal.
Along with resistors,diodes can be used in non-linear wave shaping circuits to get required altered outputs. Either the shape of the wave can be attenuated or the dc level of the wave can be altered.