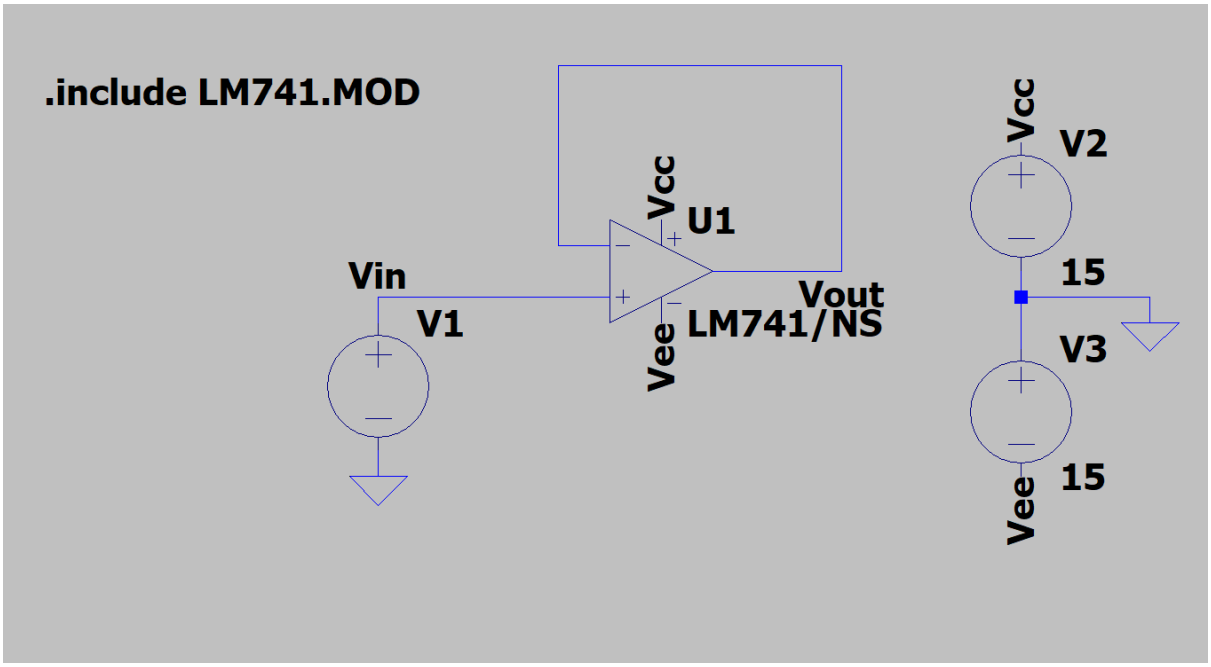
Aim: To study Opamp non-idealities mainly slew rate using LT Spice.

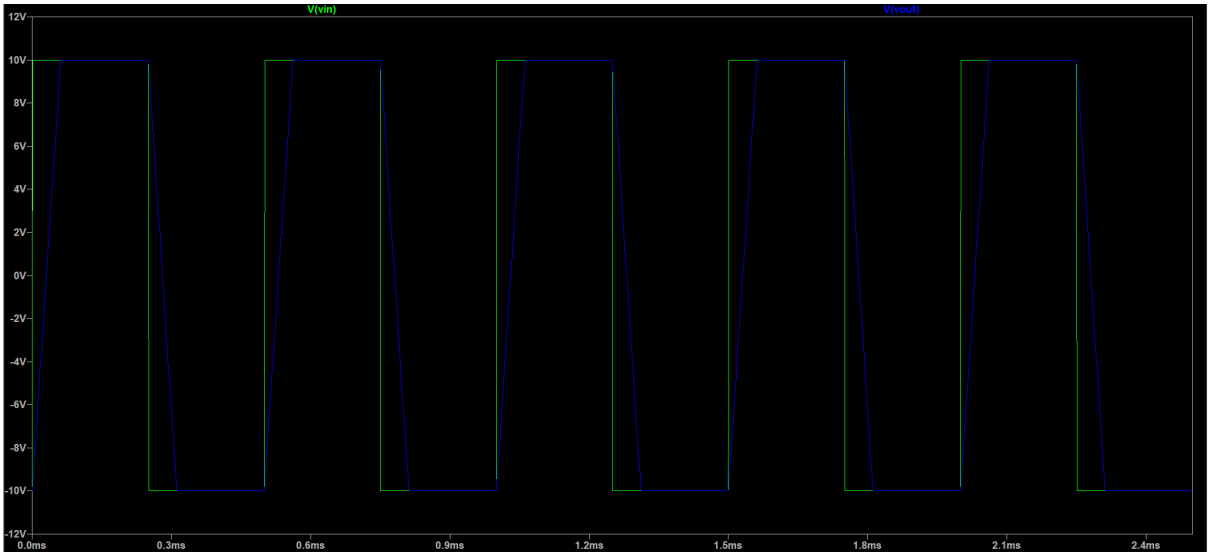
Software used: LTspice

1) <u>Effect of slew rate on the square wave with Vm=10V for 2kHz and 50kHz frequencies:</u>

Circuit:

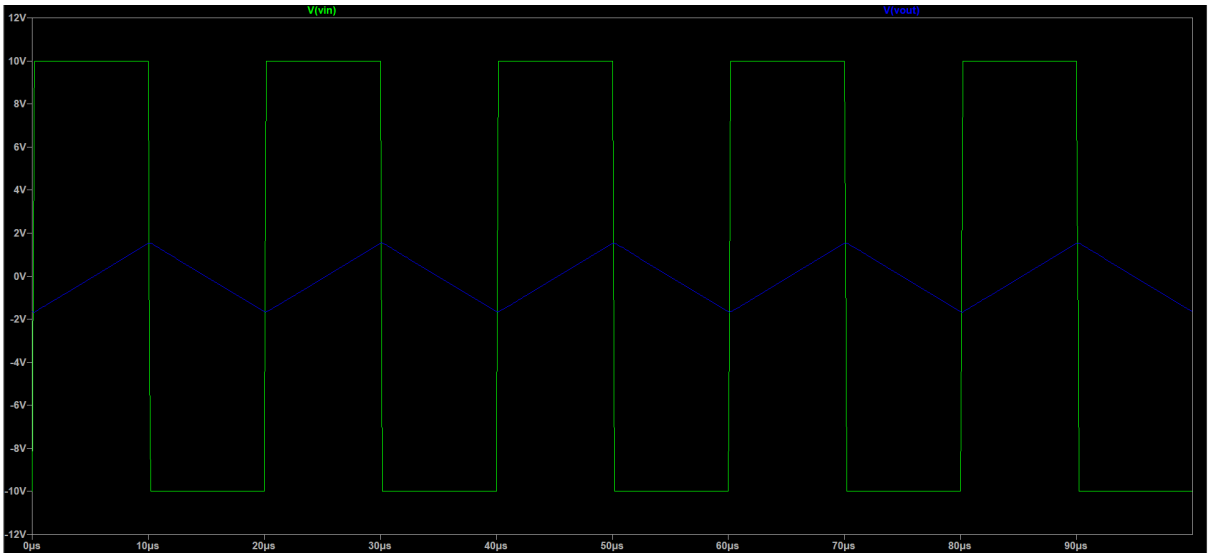


Case 1: Input and Output voltages on the scope when frequency = 2kHz



- From the plot of output voltage the slew rate observed is approximately 0.4V/us
- Theorotical value of slew rate for LM741 opamp = 0.5V/us

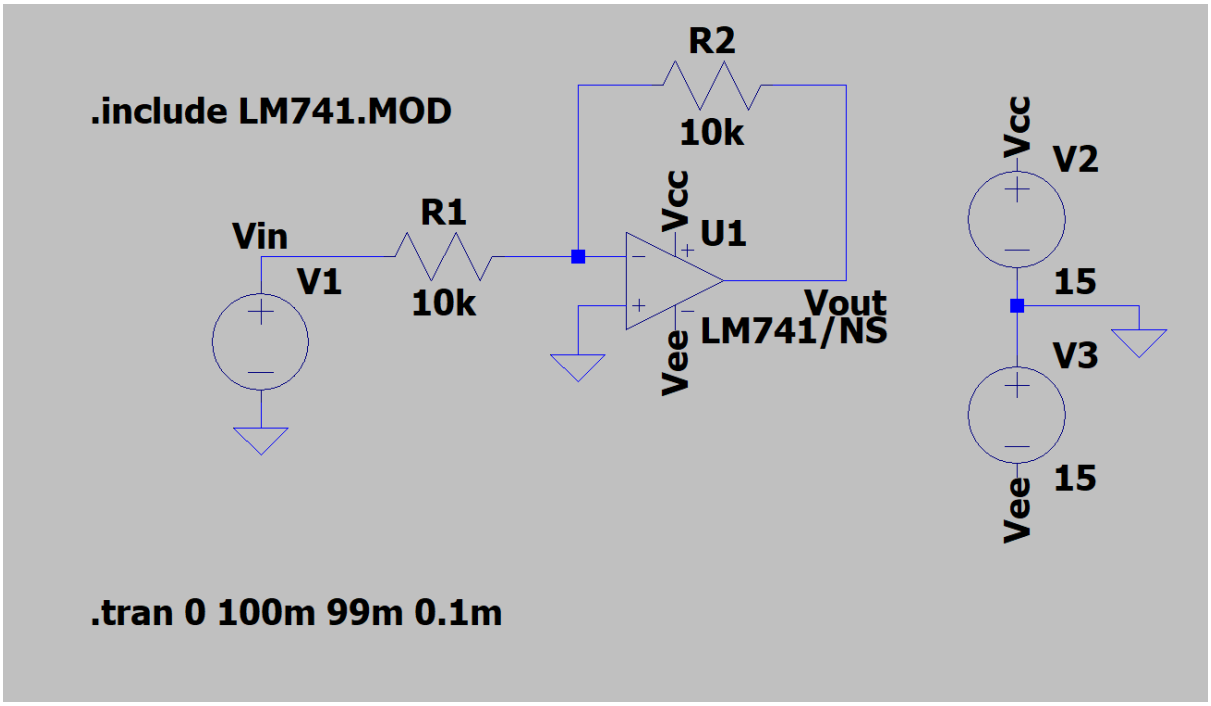
Case 2: Input and Output voltages on the scope when frequency = 50kHz



- From the plot of output voltage the slew rate observed is approximately 0.4V/us
- Theorotical value of slew rate for LM741 opamp = 0.5V/us

2) <u>Effect of slew rate on the sine wave with Vm=8V for f>fmax and f<fmax:</u>

Circuit:



Determining the maximum frequency for input sine wave of amplitude 8V

Let the maximum frequency of input sine wave be f_{max}.

$$V_{in}(t) = V_m \sin(2\pi f t)$$

for an undistorted output from op-amp,

maximum value of rate of change in $V_{in}(t)$ < slew rate

$$\Rightarrow \max\left(\frac{d V_{in}(t)}{dt}\right) < \text{slew rate}$$

$$\Rightarrow \max\left(V_m 2\pi f \cos(2\pi f t)\right) < \text{slew rate}$$

$$\Rightarrow V_m \times 2\pi f < \text{slew rate}$$

for LM 741 op amp, slew rate = 0.5 V/μs

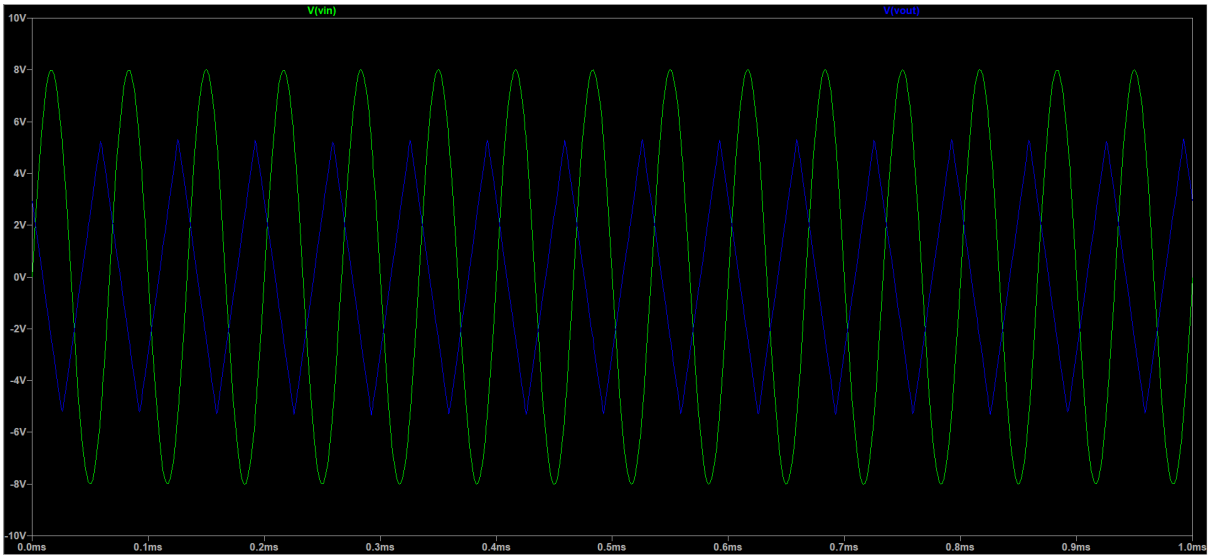
$$\Rightarrow V_m \times 2\pi f < 0.5 \text{ V/μs}$$

$$\Rightarrow f_{max} = \frac{0.5 \times 10^6}{8 \times 2\pi} \text{ Hz} \quad (\text{since, } V_m = 8\text{ V})$$

$$\Rightarrow f_{max} \approx 9.95 \text{ kHz}$$

Case 1: Input and Output voltages on the scope when **f>fmax**

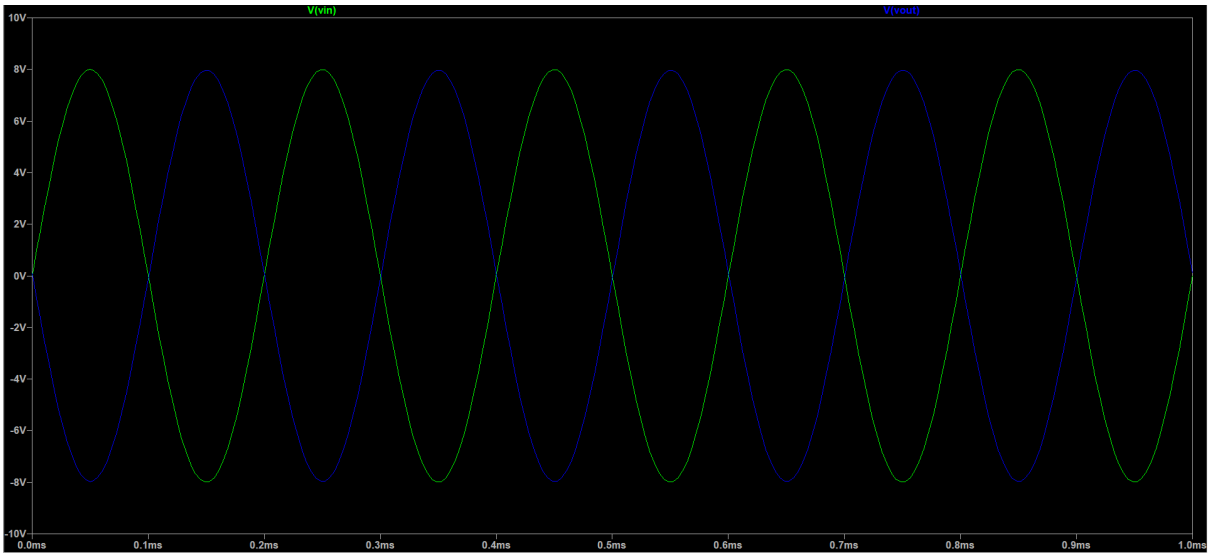
f = 15 kHz



Since, the frequency of input sine wave is greater than the fmax value, the output appeared at output terminal of op amp is distorted and a triangular wave is observed.

Case 2: Input and Output voltages on the scope when **f<fmax**

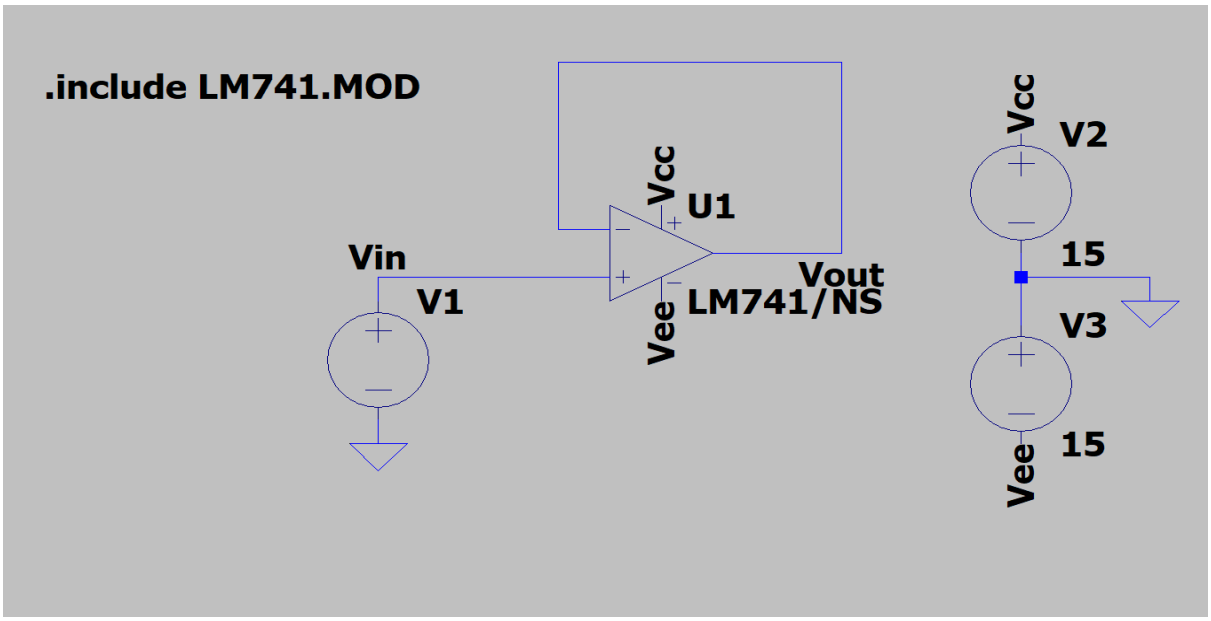
f = 5kHz



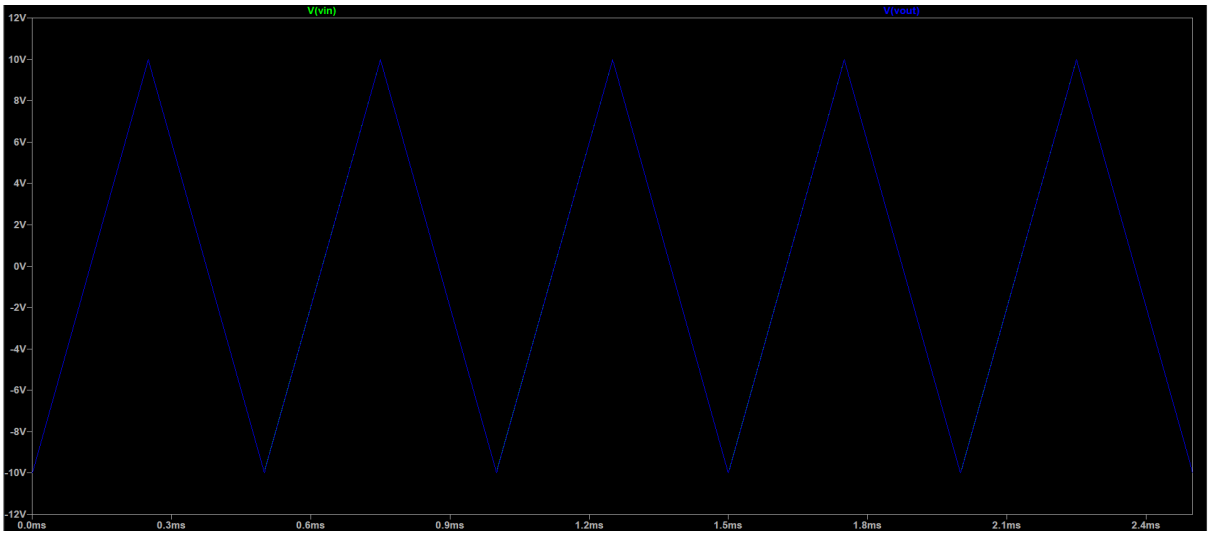
As the frequency of input sine wave is less than the fmax value, the output appeared at output terminal of op amp is the ideal output of inverting op amp which is input sine wave phase shifted by 180 degrees.

3) <u>Effect of slew rate on the triangular wave with Vm=10V for 2kHz and 50kHz frequencies:</u>

Circuit:

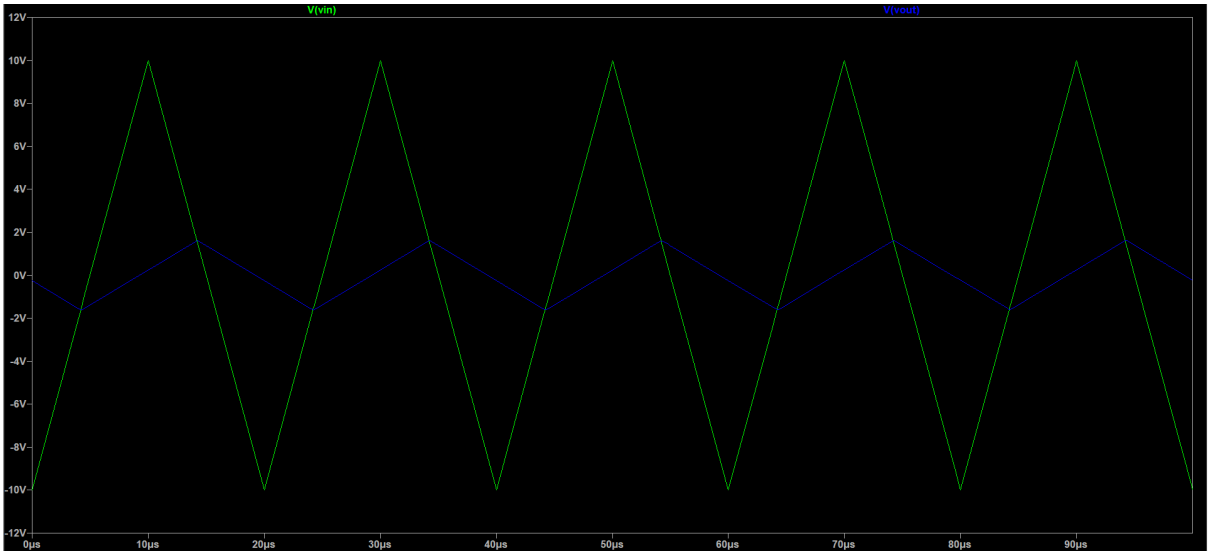


Case 1: Input and Output voltages on the scope when frequency = 2kHz



As the slope of input triangular wave (0.08 V/us) is less than slew rate of LM741, the output waveform follows the input waveform

Case 2: Input and Output voltages on the scope when frequency = 50kHz



As the slope of input triangular wave (2 V/us) is greater than observed slew rate of LM741 (0.4 V/us), the output waveform is distorted since the maximum rate of increase in voltage at output terminal of op amp is slew rate

- From the plot of output voltage the slew rate observed is approximately 0.4V/us
- Theorotical value of slew rate for LM741 opamp = 0.5V/us