Lab Report 5: Op-Amp Applications

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Objective

To study the applications of operational amplifiers (Op-Amps) by implementing:

- Custom weighted summing and difference amplifier
- Op-Amp integrator
- Precision rectifier (Super Diode)

Apparatus

- Operational Amplifiers (LM358, LM741, TL081)
- Resistors (selected for proper weighting and circuit operation)
- Capacitors (for integration circuit)
- Diodes (e.g., 1N4148 for rectification)
- DC power supply
- Function generator
- Oscilloscope

Theory

1. Custom Weighted Summing and Difference Amplifier

A summing amplifier combines multiple inputs with specified gains. Using an inverting summing amplifier configuration:

$$V_{out} = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3\right) \tag{1}$$

For specific resistor values, the desired expressions can be achieved:

$$V_{out} = 2V_1 + V_2 - V_3 \tag{2}$$

$$V_{out} = 2V_1 - V_3 \tag{3}$$

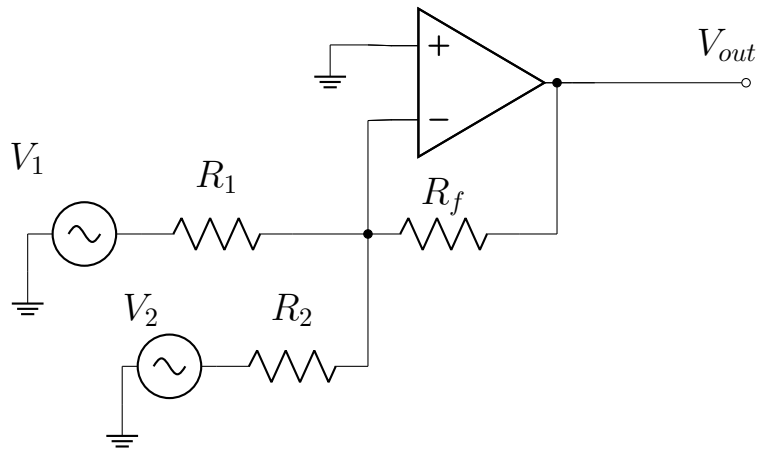


Figure 1: Summing and Difference Amplifier Circuit

2. Op-Amp Integrator

An Op-Amp integrator mathematically integrates the input signal:

$$V_{out} = -\frac{1}{RC}\int V_{in}dt \tag{4}$$

It converts a square wave input into a triangular wave output and is useful in signal processing applications.

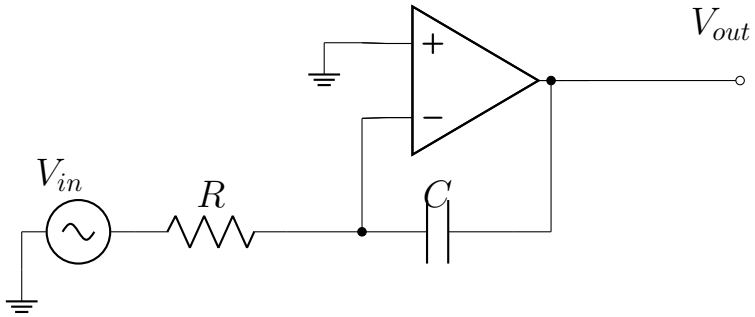


Figure 2: Op-Amp Integrator Circuit

3. Precision Rectifier (Super Diode)

A precision rectifier eliminates the 0.7V drop of standard diodes by using an Op-Amp:

$$V_{out} = \begin{cases} 0, & V_{in} < 0 \\ V_{in}, & V_{in} > 0 \end{cases} \tag{5}$$

For a full-wave rectifier, an additional summing stage is used to combine positive and inverted negative portions.

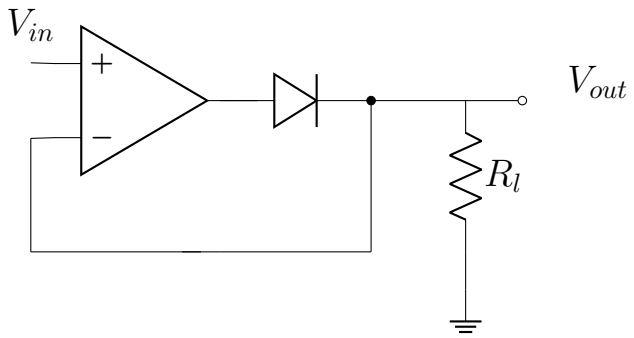


Figure 3: Precision Rectifier Circuit

Procedure

1. Assemble each circuit as per the given schematics.
2. Apply appropriate input signals using a function generator.
3. Measure output using an oscilloscope.
4. Compare theoretical and experimental results.
5. Record observations and plot graphs.

Observations

Summing and Difference Amplifier

$R_1 = R_2 = 2k\Omega$, $R_3 = 1k\Omega$

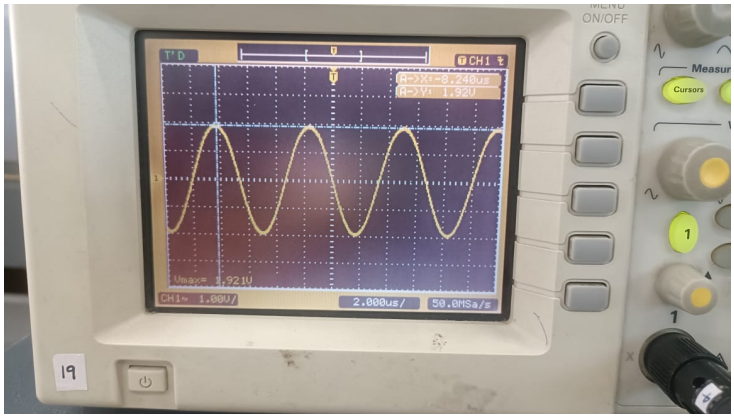


Figure 4: $V_1 = V_2 = sin(2\pi ft)$ $f = 150kHz$

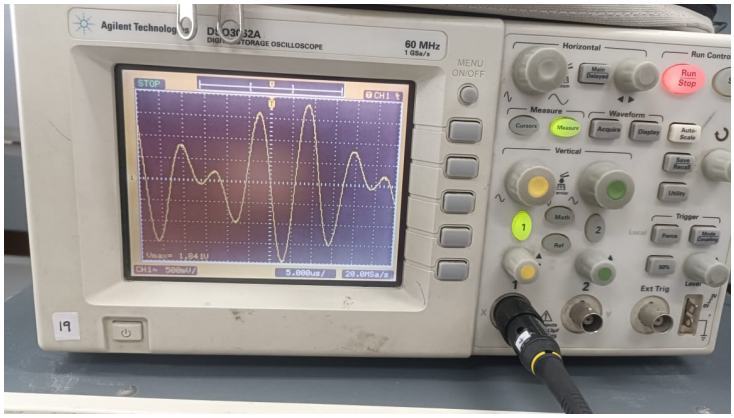
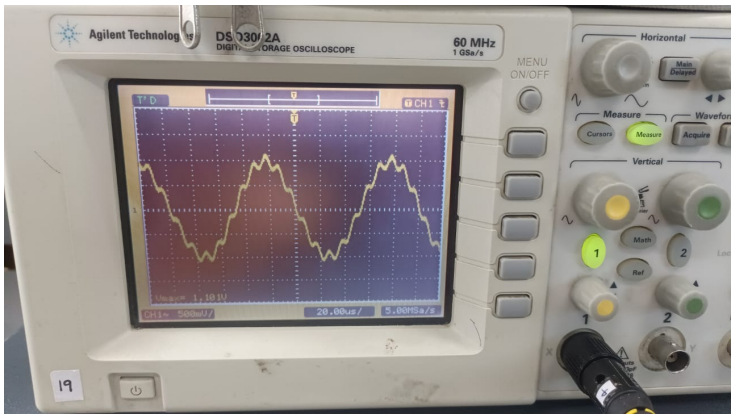
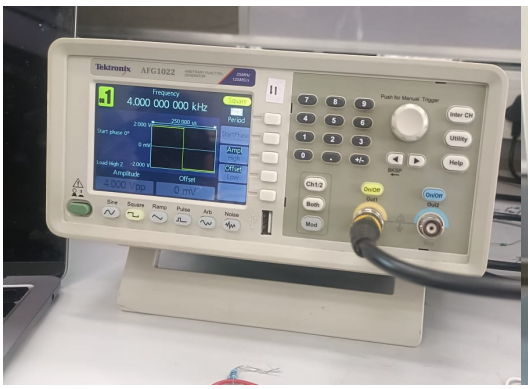
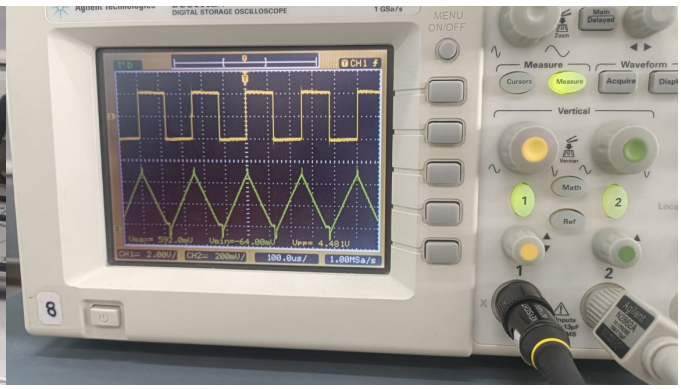


Figure 5: $V_1 = sin(2\pi f_1 t), V_2 = sin(2\pi f_2 t), f_1 = 75kHz, f_2 = 100kHz$



Op-Amp Integrator

Precision Rectifier