Lab 4: Simple Analogue Signal Processing

1 Objectives

The purpose of this lab is to implement simple electric circuits that perform basic signal operations on analogue signals such as amplitude scaling, addition, differentiation or integration.

2 Equipments

1. A signal generator, an oscilloscope.
2. **Breadboard (bring your own one).**
3. Resistors, capacitors, Op-amp (LM741, see the last page for the pin layout) , diodes.

3 Background

A thorough review of Lecture 4 is necessary to complete all the tasks in the next section.

4 Procedures

4.1 Amplitude Scaling

Construct a circuit shown in Figure 1 and choose R1 $= 10$ KΩ and R2 $= 4.7$ KΩ. The output voltage to be measured is Vo shown in Fig. 1

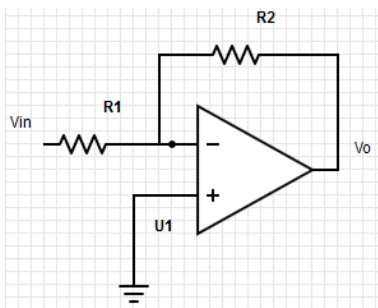


Figure 1: A amplitude scaling circuit.

Task 1 Set Vin to be 5V (DC) and measure Vo.

Task 2 Change Vin in the range from 0V to 5V, measure Vo and plot Vo as a function of Vin. Give your comments on the obtained results in relation to the theory.

Task 3 Change Vin to a square signal 5Vpp. You can choose an arbitrary frequency for the square signal. Observe the output signal on an oscilloscope and compare the obtained signal with the theoretical analysis.

4.2 Summing Amplifier

Construct the circuit shown in Figure 2 below. Choose R1 $= $ R3 $= 10$ KΩ, R2 $= 10$ KΩ, Vin $= 5$V DC.

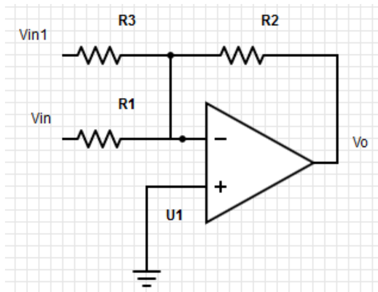


Figure 2: A diagram of a a sum amplifier.

Task 4 Generate a 5Vpp square signal at Vin1. Observe output signal and give your comments.

Task 5 Repeat Task 4 with a triangular signal.

Task 6 Change R2 to 4.7 KΩ and repeat Tasks 4 and 5.

4.3 Differentiator

Construct the circuit shown in Figure 3 below. Choose R1 $= 1$ KΩ and C1 $= 100$ nF.

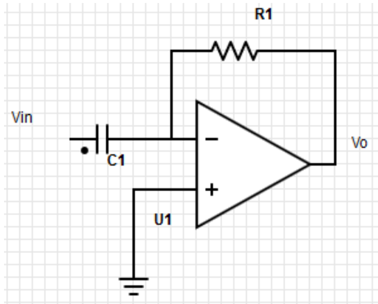


Figure 3: Differentiator circuit.

Task 7 In your report, derive the relation between Vo and Vin (Hint: Slightly modify the steps done for the RC differentiator circuit in Lecture 4).

Task 8 Generate a 5Vpp square signal at Vin, starting with a low frequency and then increasing to higher frequencies. Observe the output signal and give your comments on the obtained results.

Task 9 Repeat Task 8 for triangular and sinusoidal signals.

4.4 Integrator

Construct the circuit shown in Fig. 4 below. Choose R1 $= 1$ KΩ and C1 $= 100$ nF.

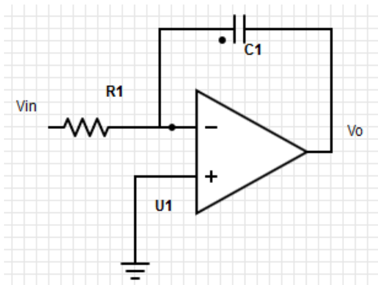


Figure 4: Integrator circuit

Task 10 In your report, derive the relation between Vo and Vin (Hint: Slightly modify the steps done for the RC integrator circuit in Lecture 4).

Task 11 Generate a 5Vpp square signal at Vin, starting with a high frequency and then increasing to lower frequencies. Observe the output signal and give your comments on the obtained results.

Task 12 Repeat Task 11 for triangular and sinusoidal signals.

4.5 Log operation

Log-amplifiers are an important part of an analogue multiplier. Construct the log-amplifier circuit given in Fig. 5 below. Choose R1 $= 1$ KΩ and obtain a diode from the lab tutors.

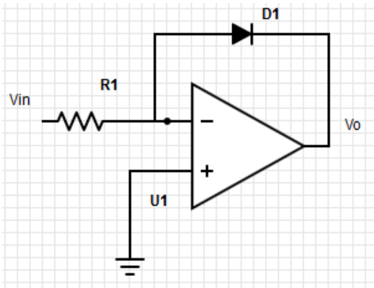


Figure 5: Log-amplifier circuit

Task 13 Derive the relation between Vo and Vin.

Task 14 The purpose of this task is to measure Vo for a number of values of Vin, ranging from 0.1V to 3.0V. To do so, we will take Vin from a voltage divider circuit in Fig. 6 shown below.

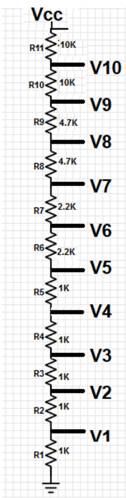


Figure 6: Voltage divider for log amplifier input

Task 15 Plot $|Vo|$ as a function of $|Vin|$. Give your comments on the obtained figure.

Task 16 Use a simulation tool of your choice (e.g. Multisim) to simulate a complete analogue multiplier circuit.

5 Reports

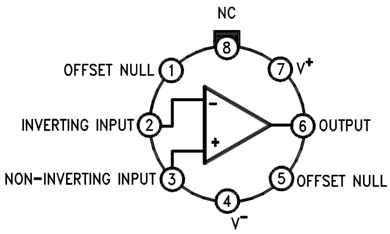
- Each student submits a **single report**.
- To be uploaded via moodle **by Friday, 17:00**.
- A penalty 10% of each day will be applied to late submission.
- Poorly written report is subject to deduction.

Required Results in Report

- A detailed drawing of the circuits used.
- Your results. When applicable, compare your experimental results with the theoretical ones.
- A summary of what you gained in the lab.

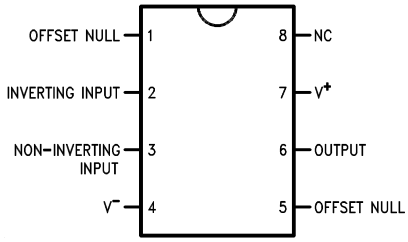
5 Pin Configuration and Functions

LMC Package
8-Pin TO-99
Top View



LM741H is available per JM38510/10101

NAB Package
8-Pin CDIP or PDIP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
INVERTING INPUT	2	I	Inverting signal input
NC	8	N/A	No Connect, should be left floating
NONINVERTING INPUT	3	I	Noninverting signal input
OFFSET NULL	1, 5	I	Offset null pin used to eliminate the offset voltage and balance the input voltages.
OFFSET NULL			
OUTPUT	6	O	Amplified signal output
V+	7	I	Positive supply voltage
V–	4	I	Negative supply voltage