AM5023- PHYSIOLOGICAL MEASUREMENTS AND INSTRUMENTATION LABORATORY

AM ELECTRONICS - LABORATORY REPORT

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MEASUREMENTS USING OSCILLOSCOPE

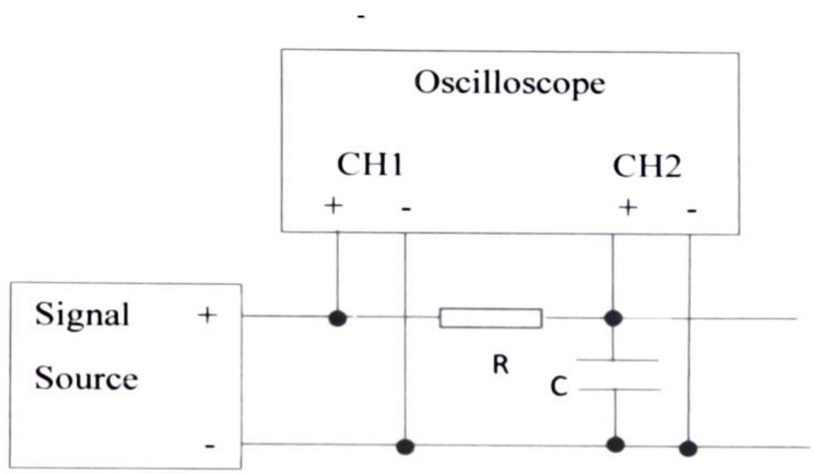
Aim :

To become familiar with basic front panel controls of Oscilloscopes and use for measurements.

Materials Required :

Signal Source, Oscilloscope with probes, Bread board, Resistor and Capacitor.

Circuit Diagram and Measurement Setup :



Useful Calculations :

For Voltage measurement : (No.of divisions on vertical axis) x (Volts / division)

For Frequency measurement :

Time = (No.of divisions on horizontal axis) x (Time / division)

Frequency = (1/ Time) Hz

Cut-off frequency of Low pass filter = (1/2*pi*R*C) Hz

Table for Measurement :

Sl.No	Signal Source		Oscilloscope			
	Amplitude (p-p)	Frequency	Horizontal axis measurement		Vertical axis measurement	
			Time	Frequency	CH1	CH2
1	5V	50 Hz	20 ms	50 Hz	5V	4.7 V
2	5V	100 Hz	10 ms	100 Hz	5V	4.2 V
3	5V	500 Hz	2 ms	500 Hz	5V	1.7 V
4	5V	1 KHz	1 ms	1 KHz	5V	0.9 V
5	5Vpp+ 1VDC	1K Hz	20 ms	50 Hz	5V	4.7 V

Procedure :

Make connections as per circuit diagram on bread board. Connect signal source and oscilloscopes to the circuit as per the measurement set-up. Using oscilloscope (with out Auto scale option), Set signal source amplitude and frequency as per the table values. Use the trigger option(s) for the stable display of signal on screen of Oscilloscope. Tabulate the horizontal and vertical axis measurements from oscilloscope. While following fifth row of Table use AC/ DC coupling options of oscilloscope to see only AC or AC+DC signal.

Results / Observations :

- Become familiar with voltage, time and frequency measurements using basic front panel controls of oscilloscope without using auto-scale option.
- Additionally, frequency response of first-order, R-C low pass filter is studied.
- In place of R-C filter, any circuit like Instrumentation amplifier, filter or any Op-amp based amplifier may be placed to study its characteristics.

INSTRUMENTATION AMPLIFIER

Aim:

To build and test the Instrumentation amplifier using op-amps.

Materials Required:

Multi-output Power Supply (DCPS), Signal Source, Oscilloscope with probes, Bread Board, Resistor (10 kohm – 7Nos) and IC LM358-2 Nos or LM324-1 No.

Theory of Operation:

In practical applications like industrial controllers and home appliances, to control and/ or display the physical quantities like light level, temperature, pressure, weight, humidity, flow of gas or water…etc, it's measurement is very important. Transducers are widely used to measure these quantities. Transducers are the sensors that convert physical quantity into electrical quantity (directly or indirectly). As the output of the transducers are very low like in the order of μV to mV, it must be amplified before fed to display or next processing circuit. The amplifier should also provide the following features for accurate and reliable measurement for better control and display. Those are

- Programmable gain
- High CMRR-Common Mode Rejection Ratio (ability to reject the common noise)
- Stable gain with low temperature sensitivity
- Low DC offset against temperature and time
- Low output impedance and high input impedance

One such a amplifier is Instrumentation Amplifier (INA) using three op-amps. The typical circuit diagram of INA is given in Figure-1. In this circuit, the first stage consists of amplifiers A1 and A2, are in Non-inverting amplifier configuration and sharing common gain resistor R_G. Second stage is typical differential amplifier. Now a days, INA is available in single chip with all required components/ circuits are integrated and require only minimal external components.

Circuit diagram:

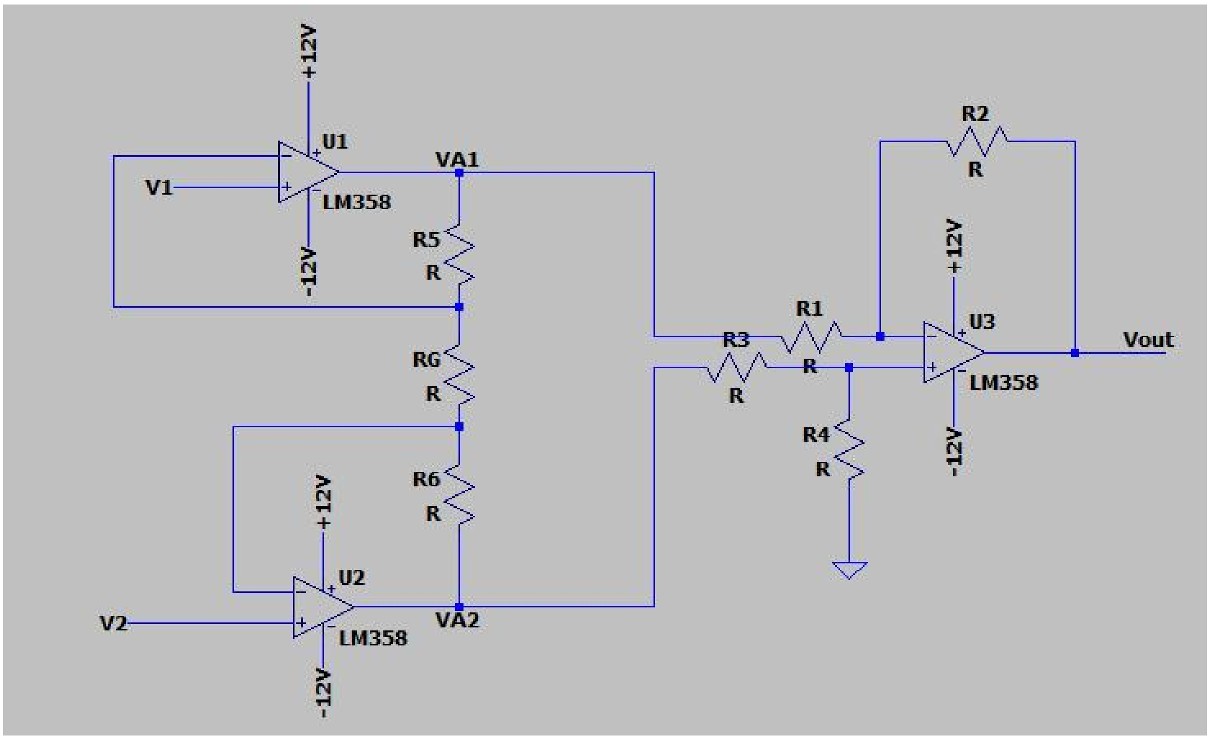


Table for measurement:

Sl. No.	Inputs		Output
	V1	**V2**	
1	5V DC	4V DC	-2.77 V
2	5V DC	6V DC	3.11 V
3	4V DC	5V DC	3.08 V
4	0V	1Vpp-1kHz sine	$V_{OD} = 2.6$ V
5	1Vpp-1kHz sine	1Vpp-1kHz sine	$V_{oc} = 0.4$ mV

Useful design Equations:

A3 amplifier stage:

For R1 = R3 and R2 = R4, Vout = (R2 /R1)*(VA2 – VA1)

First stage amplifier:

For, R6 = R5

VA1 = {(R5 +RG) * V1 – (R5*V2)} /RG

VA2 = {(R5+RG) *V2-(R5*V1)}/RG

Combined circuit:

Vout = (R2 / R1) * (1+2R5/RG) * (V2-V1)

Procedure:

Calculate the resistance values for overall gain of 3. Using these resistance values, make connections as per the circuit diagram on bread board. Give the input voltages V1 and V2 as per the Table. Record the amplifier response (Vout). Calculate the following values from the observations.

$CMRR = 20\log|A_d / A_c|$ dB

$A_d = V_{OD} / (V1 - V2)$ and $A_c = V_{OC} / (V1 \text{ or } V2)$

Results / Observations:

- Wired and tested the Instrumentation Amplifier (INA).
- The theoretical gain of INA = **3** and observed gain = **2.9.**
- Observed CMRR = **76.25 dB.**