INSTRUMENTATION AMPLIFIER

Department of Electronics and Instrumentation Engineering

Submitted By: GROUP 9

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Lab Contents:

I.Objective:

Design of instrumentation amplifier using transducer bridge.

II. Software used:

MATLAB (Version 2015a)

III. Theory:

The resistive transducer bridge is a network of resistors whose resistance varies due to changes in some physical condition.For example, thermistors change their resistance with temperature and Light Dependent Resistors change their resistance due to change in light intensity.

By making such a bridge as a part of the circuit, it is possible to produce an electrical signal proportional to the change in the physical quantity being measured. Such an electrical signal can be amplified and used to monitor and control the physical process.

An instrumentation amplifier is an integrated circuit (IC) that is used to amplify a signal. This type of amplifier is in the differential amplifier family because it amplifies the difference between two inputs. The importance of an instrumentation amplifier is that it can reduce unwanted noise that is picked up by the circuit. The ability to reject noise or unwanted signals common to all IC pins is called the common-mode rejection ratio (CMRR). Instrumentation amplifiers are very useful due to their high CMRR. Other characteristics, such as high open loop gain, low DC offset and low drift, make this IC very important in circuit design.

In the circuit diagram below, R_a, R_b and R_c are three resistances in the Wheatstone bridge setup and R_t is the variable resistance, which is changed to obtain unbalanced condition output voltage.

When the bridge is balanced,

$R_a (V_{dc})/ (R_a+R_t) = R_b (V_{dc})/ (R_b+R_c)$………….. (i)

When there is a change in the physical quantity being measured, the resistance of the transducer device changes from R_t to $(R_t \pm \Delta R)$.

$V_b = R_b (V_{dc})/ (R_b+R_c)$…………….. (ii)

$V_a = R_a (V_{dc})/ (R_a+R_t+\Delta R)$……………. (iii)

Differential voltage

$V_{Diff} = \Delta R (V_{dc})/ \{2(2R+\Delta R)\}$ (If $R_a = R_b = R_c = R_t = R$)………… (iv)

The output of the instrumentation amplifier is given as,

$V_O = (R_3/R_2)V_{Diff}$ ………… (v)

$V_O = (R_3/R_2) [\Delta R (Vdc)/ \{2(2R+\Delta R)\}]$………….. (vi)

As the change in resistance $\Delta R << 2R$, V_0 can be written as,

$V_0 = (R_3/R_2)\ [\Delta R/4R]\ (V_{dc})$.............. (vii)

Here, values taken:

$R_a = R_b = R_c = 100$ kohm

$V_{dc} = 5V$

$R_1 = R_2 = 1$ kohm

$R_f = R_3 = 4.7$ kohm

Components used in circuit:

- Op-amps
- Resistances,
- DC voltage source,
- voltage sensors,
- solver configuration,
- PS-Simulink converters,
- scope,
- display
- multiplexer
- wires

IV. MATLAB circuit diagram:

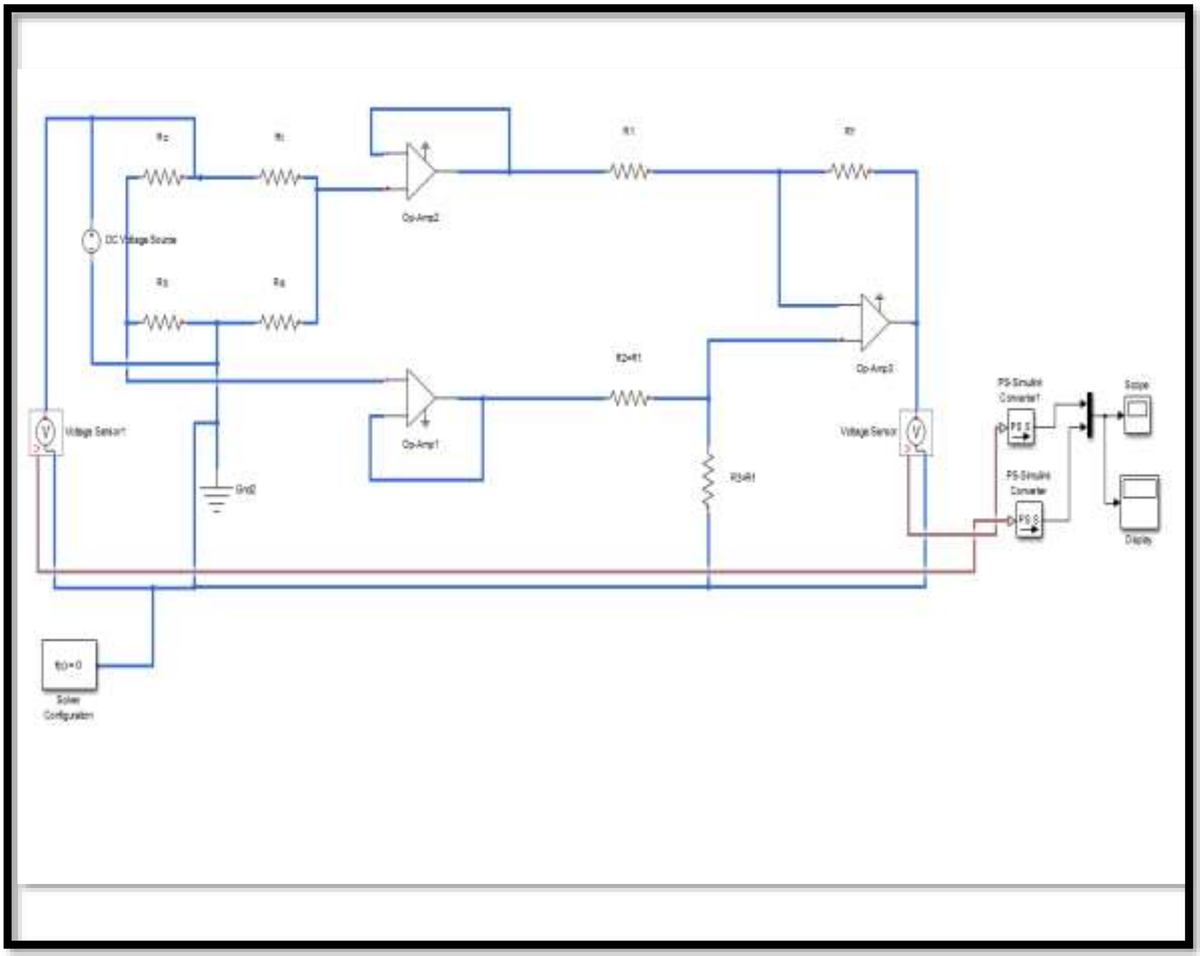
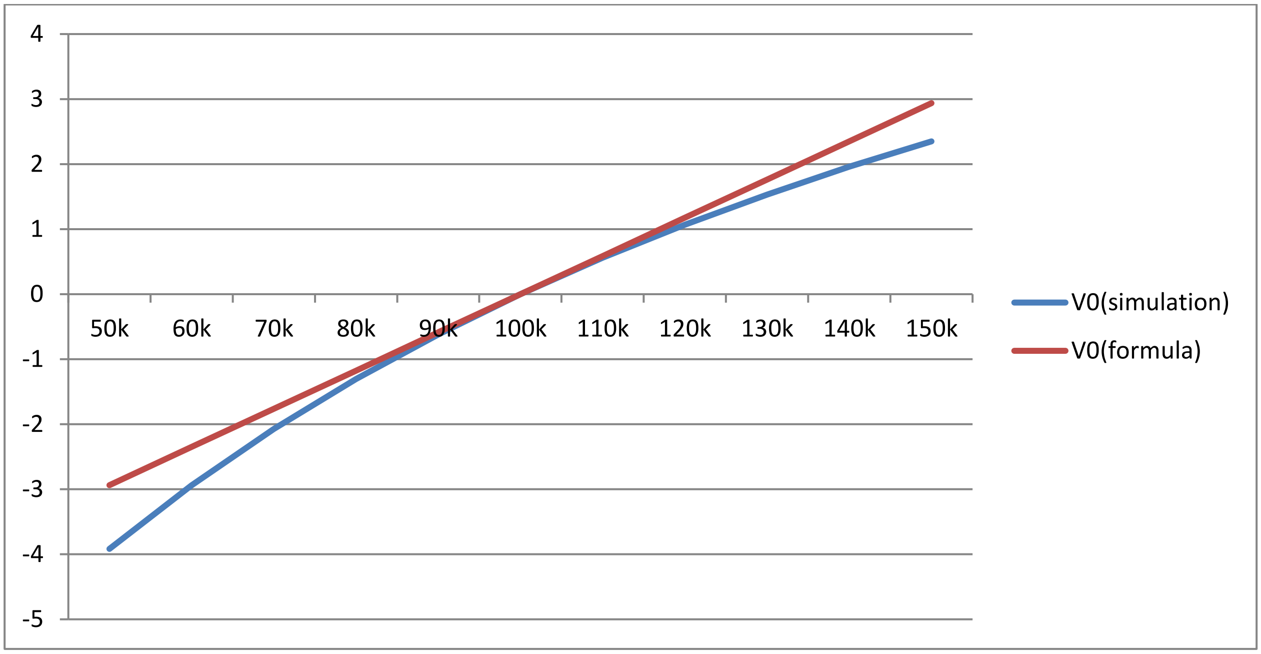


Fig:Instrumentation Amplifier

V. Table:

R (Kohm)	V_0(from simulation)(V)	V_0(from calculations)(V)
50k	-3.917	-2.9375
60k	-2.938	-2.35
70k	-2.074	-1.7625
80k	-1.306	-1.175
90k	-0.6184	-0.5875
100k	$1.11*10^{-15}$	0
110k	0.5595	0.5875
120k	1.068	1.175
130k	1.533	1.7625
140k	1.958	2.35
150k	2.35	2.9375

VI. Graph:



Graph: R vs expected O/P voltage

VII. Conclusion:

The instrumentation amplifier circuit designed in MATLAB gives some error in the output voltage for resistance 100 kohm which may be due to some offset error in the op-amps used, which amplify small errors between their terminals.