NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

ELECTRICAL MEASUREMEMT LABORATORY (EES-351)

EXPERIMENT - 2 :-

Measurement of Displacement by using LVDT

Date of Experiment :- 2nd June 2021

GROUP - V

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EXPERIMENT 2

AIM OF THE EXPERIMENT: Measurement of Displacement by using LVDT

OBJECTIVE: Determining the sensitivity of LVDT by plotting output voltage Vs displacement using LVDT sensor.

APPARATUS REQUIRED:

SL NO	INSTRUMENT NAME	SPECIFICATION	QUANTITY
1	Power Supply (AC)	220V, 50Hz	1
2	Linear Variable Differential Transformer (LVDT)	Soft Iron core (Fe-Ni) least count of Scale = 0.1mm	1

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THEORY

The linear variable differential transformer (LVDT) is a type of electrical transformer used for measuring linear displacement. The transformer has three solenoidal coils placed end to end around a tube. The centre coil is the primary and the two outer coils are the secondaries. A cylindrical ferromagnetic core, attached to the object whose position is to be measured, slides along the axis of the tube.

An alternating current is driven through the primary causing a voltage to be induced in each secondary proportional to its mutual inductance with the primary. The frequency is usually in the range 1 to 10KHz.

As the core moves, these mutual inductances change causing the voltages induced in the secondaries to change. The coils are connected in reverse series, so that the output voltages is the difference (hence "differential") between the two secondary voltages. When the core is in its central position, equidistant between the two secondaries, equal but opposite voltages are induced in these two coils, so the output voltage is zero.

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When the core is displaced in one direction, the voltage in one coil increases as the other decreases, causing the output voltage to increase from zero to a maximum. This voltage is in phase with the primary voltage. When the core moves in the other direction, the output voltage also increases from zero to a maximum but its phase is opposite to that of primary. The magnitude of the output voltage is proportional to the distance moved by the core (up to its limit of travel), which is why the device is described as "linear". The phase of the voltage indicates the direction of displacement. Because the sliding core does not touch the inside of the tube, it can move without friction, making the LVDT a highly reliable device. The absence of any sliding or rotating contacts allows the LVDT to be completely sealed against the environment.

LVDTs are commonly used for position feedback in servomechanisms and for automated measurement in machine tools and many other industrial and scientific applications.

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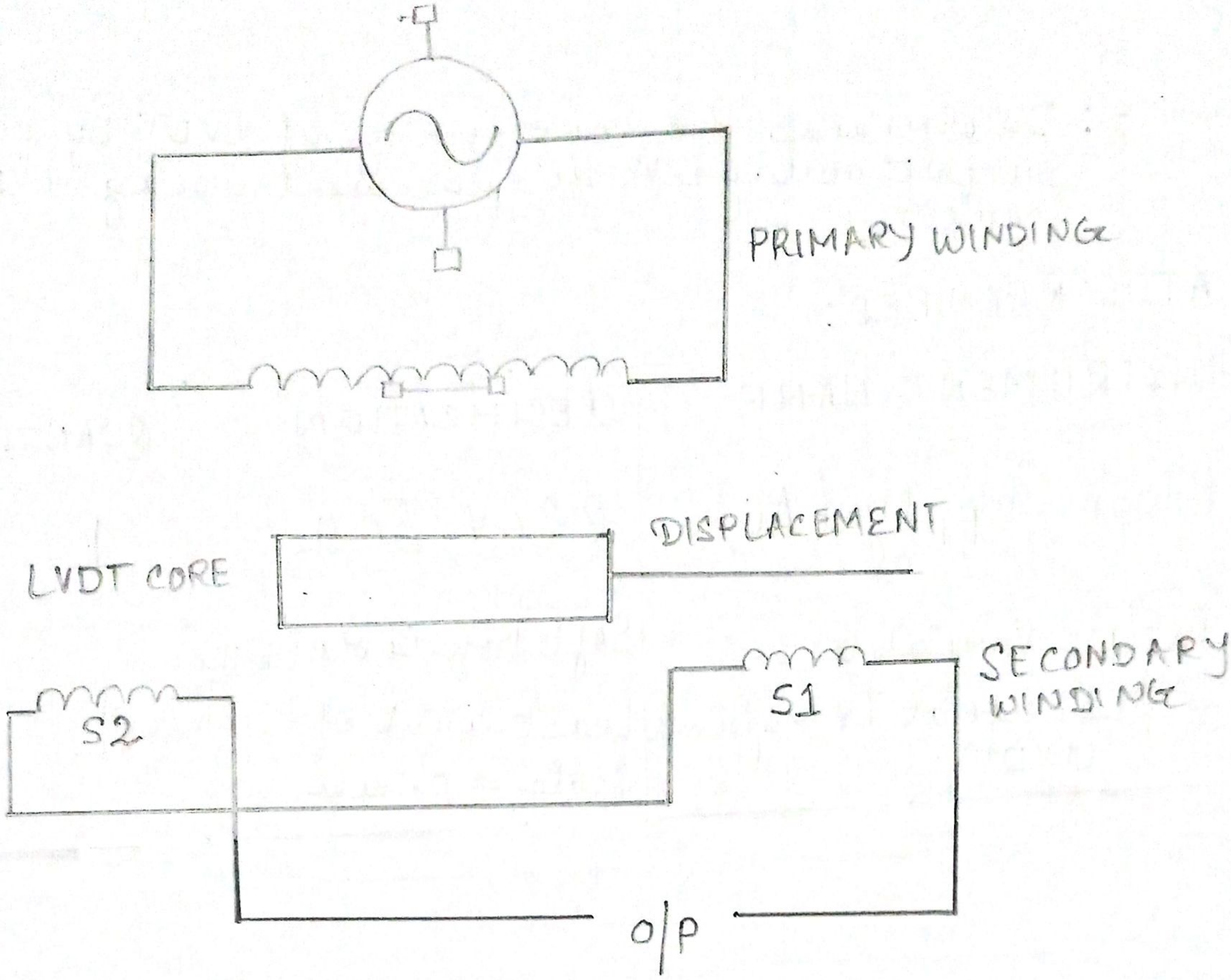
CIRCUIT DIAGRAM:



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EXPERIMENTAL RESULTS : At NULL Condition :
Displacement = 0 mm
Voltage = 0 mV

SL NO	CLOCKWISE DIRECTION		ANTICLOCKWISE DIRECTION	
	DISPLACEMENT (mm)	VOLTAGE (mV)	DISPLACEMENT (mm)	VOLTAGE (mV)
1	0	0.8	0	0.8
2	0.5	1.7	0.5	1.7
3	1	2.6	1	2.6
4	1.5	3.5	1.5	3.5
5	2	4.4	2	4.4
6	2.5	5.3	2.5	5.3
7	3	6.2	3	6.2
8	3.5	7.1	3.5	7.1
9	4	8	4	8
10	4.5	8.9	4.5	8.9
11	5	9.8	5	9.8
12	5.5	10.7	5.5	10.7
13	6	11.6	6	11.6
14	6.5	12.5	6.5	12.5
15	7	13.4	7	13.4

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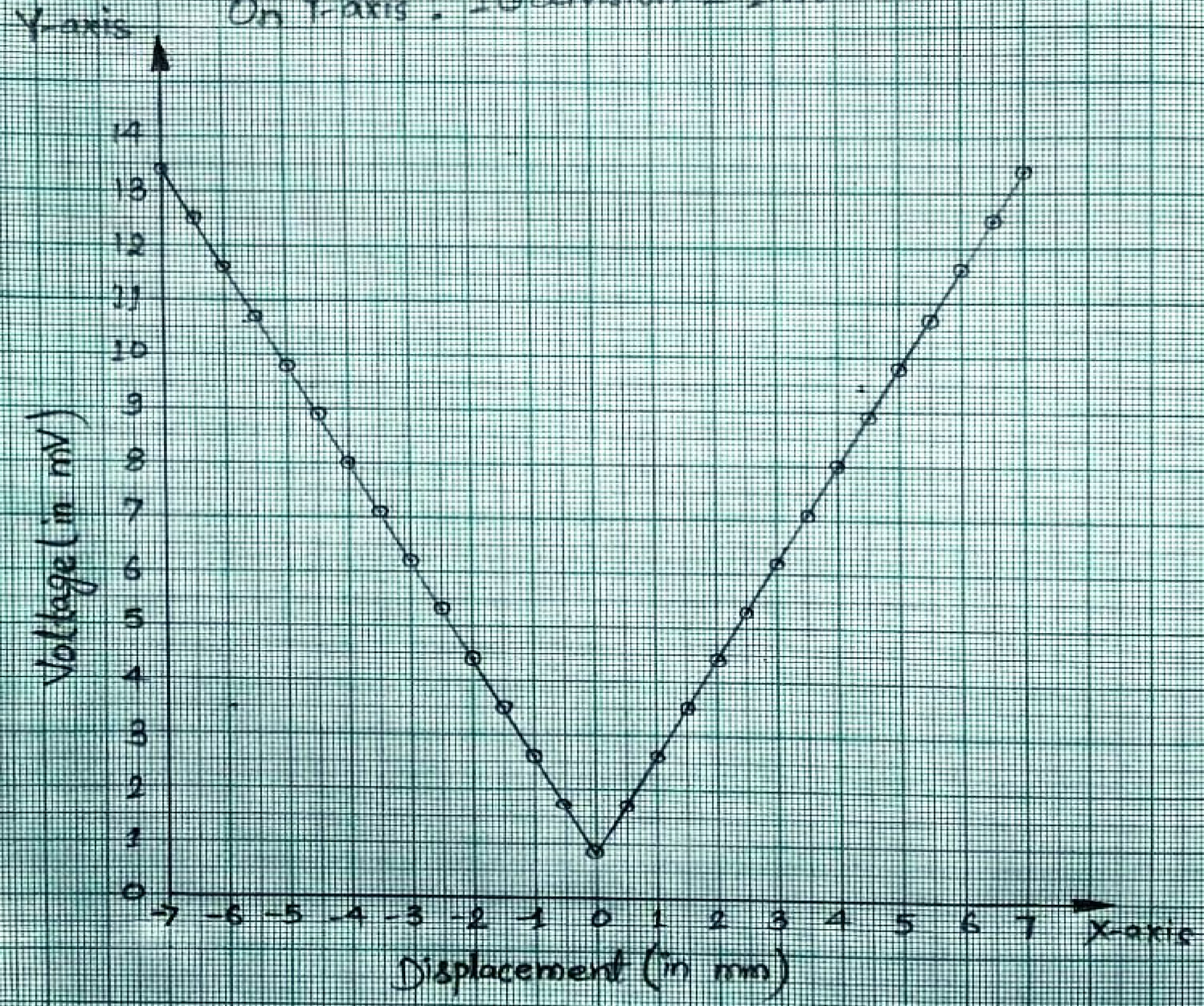
Voltage vs Displacement for LVDT

Scale:

On X-axis: 10 division = 1mm

On Y-axis: 10 division = 1mV



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CALCULATIONS | ROUGH WORK

A graph is drawn by plotting output voltage Vs displacement. From the graph, residual voltage and sensitivity of LVDT can be found.

$$\text{Sensitivity of the LVDT} = \frac{\text{Output Voltage}}{\text{Displacement}}$$

$$= \frac{\Delta y}{\Delta x} = \frac{8 - 7.1}{4 - 3.5} = 1.8\,\text{mV/mm}$$

$$\text{Residual Voltage} = 0.8\,\text{mV}$$

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CONCLUSION

1. At the null position, the voltages induced in both the secondary windings S_1 and S_2 are equal $\rightarrow E_{S1} = E_{S2}$
From ~~theory~~ and experimentation, we see at NULL,
$E_0 = E_{S1} - E_{S2} \simeq 0 \rightarrow$ the differential voltage is zero.
The deviation from theory (0V) is due to appearence of residual voltage.

2. When the LVDT core moves in the anticlockwise direction, more flux links with S_1 and less with winding S_2. Accordingly, $E_{S1} > E_{S2}$ and $E_0 = E_{S1} - E_{S2}$ and it is in phase with primary voltage.

3. when moved clockwise, $E_{S2} > E_{S1}$ and hence E_0 will be 180° out of phase with primary voltage.

4. The amount of voltage change in either of the secondary winding is proportional to the amount of movement of the core. Hence, we have an indication of amount of linear motion.

5. The sensitivity of the LVDT transducer is found to be 1.8mV/mm.

6. The residual voltage of the LVDT transducer is found to be 0.8mV.

7. For a good transducer, it must have linearity, with high ruggedness, reliability and stability along with high output signal quality. LVDT has all these properties with good linearity (proven from graph), good resolution and sensitivity and consumes low power.

8. The appearance of the residual voltage is due to presence of harmonics in supply voltage, presence of stray capacitance between primary and secondary winding, mismatch between the two secondary windings and presence of ferromagnetic core.

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