



**ELECTRICAL INSTRUMENTATION**  
**LAB MANUAL**  
**(EEN-751)**

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# **SYLLABUS**

## **EEN-751/EEE-553: ELECTRICAL INSTRUMENTATION LAB.**

**Note:** Minimum 10 experiments should be performed from the following

1. Measurement of displacement using LVDT.
2. Measurement of displacement using strain gauge based displacement transducer.
3. Measurement of displacement using magnetic pickup.
4. Measurement of load using strain gauge based load cell.
5. Measurement of water level using strain gauge based water level transducer
6. Measurement of flow rate by anemometer
7. Measurement of temperature by RTD.
8. Measurement of temperature by thermocouple
9. Study of P, PI and PID controllers
10. Study of storage oscilloscope and determination of transient response of RLC Circuit.
11. Determination of characteristics of a solid state sensor/fibre-optic sensor
12. Design and test a signal conditioning circuit for any transducer
13. Study of data acquisition system using “**lab view**” software and test all signal points

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## **STUDY AND EVALUATION SCHEME**

### **SESSIONAL EVALUATION:-**

**CLASS TEST : 10 MARKS**

**TEACHER'S ASSESMENT : 10 MARKS**

**EXTERNAL EXAM : 30 MARKS**

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**TOTAL : 50 MARKS**

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## INDEX

S.NO.	NAME OF EXPERIMENT	SIGNATURE OF FACULTY/ DATE OF EVALUATION	GRADE

# EXPERIMENT NO. 1

**Object:** To study characteristics of LVDT.

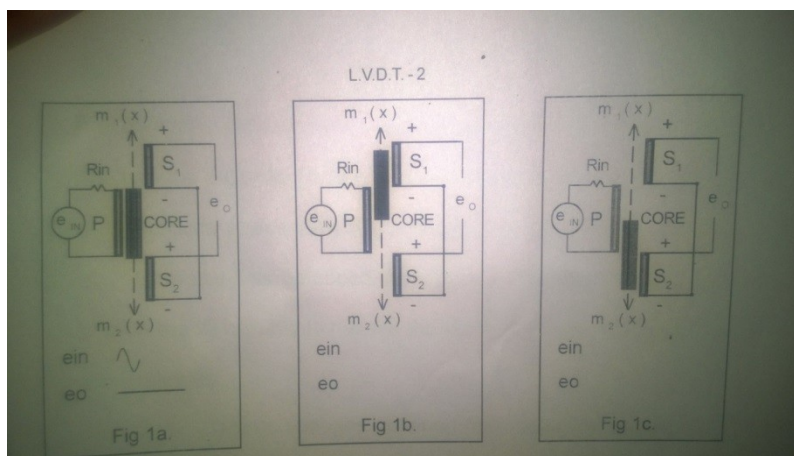
**Apparatus Required:-**

S. No.	Name of equipment	Range	Rating	Quantity	Type

**Theory:-**

LVDT is used to measure position and displacement. LVDT consists of two identical secondary (symmetrically placed on both sides of primary). One primary coil and a movable core called actuator. The displacement to be measured is transferred to the magnetic core in the flux linkage. When the primary coil is connected to a sinusoidal excitation source, the amount of voltage on the secondary  $S_1$  and  $S_2$  depends on the position of the core  $m_1(x)$  or  $m_2(x)$  corresponding to null position  $x$ . There are three positions that can be accounted. First (a), core is placed centrally (within the primary coil area) hence  $x=0$ . Second (b), towards coil  $S_1$  side where  $x=\Delta x$ . Third (c), towards coil  $S_2$  side where  $x=-\Delta x$ . In situation first the minor flux linkage obtained called residual flux, but as the  $S_1$  and  $S_2$  are connected in antiseriess way the output is negligible due to phase cancellation between these minor voltages. In position (b) the  $S_1$  and primary have maximum linkage the output voltage  $e_o$  will be more than (a) in polarity similar to the excitation signal. In position (c) the output voltage  $e_o$  will be again more than (a), but in opposite polarity than  $e_o$ . The magnitude of output voltage  $e_o$  depends upon the displacement of the core to either side, while the polarity depends upon the core position. Thus LVDT is a transformer which can produce an output voltage in accordance with displacement and position.

**Circuit Diagram/Block Diagram:**



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**Procedure:-**

1. Connect CRO one channel (ground lead with ground) across the primary of LVDT sockets. Connect other channel with secondary output.
2. Select internal oscillator mode by mean of switch provided upon panel. Measure input voltage  $e_{in}$ , across primary by CRO.
3. Adjust micrometer (actuator) to lead zero (0) on its scale adjust zero, adjust control provided near scalar gain control to read DPM 0.00 observe that, trace upon CRO channel connected across secondary has the lowest amplitude. To observe it rotate micrometer slightly to both side in respect of '0' mark and see that amplitude is minimum at balance condition.
4. Observe residue ac signal (with its noise level) as residual ac signal. To measure ac output voltage at secondary better to use ac multivoltmeter.
5. Increase/decrease (rotate) micrometer to either side upto 2mm. Adjust scalar gain control for the displaced reading i.e 2.00 or -2.00mm.
6. Read just micrometer to again '0' and note that for any shift, if occurred reconnect it with zero adjust control.
7. Repeat step 6 again to ensure the scalar adjustment.
8. Rotate micrometer towards same position (step 6) and note the readings of ac output voltage at secondary as  $e_o$  w.r.t micrometer reading & at DPM as displacement reading w.r.t micrometer in mm upto 10mm.
9. Rotate micrometer in other direction towards outside and adjust 2.00mm calibration as before to null out the micrometer lag and residue effect. Note the readings from 0 to 10mm as above step.

**Observation table:-**

S. No.	$\uparrow S_1$ in volts	$\downarrow S_1$ in volts	Micrometer in mm	$\uparrow$ Display in mm	$\downarrow$ Display in mm

**Mathematical calculation:-**

Formulae used:

1.  $E_o = e_{in} j\omega(m_1(x) - m_2(x)/\tau + j\omega L_p$

$M_1$  &  $M_2$  are the mutual inductances.

$\tau$  is the wavelength.

2. Sensitivity of LVDT =  $\text{output voltage} / \text{displacement in mm.}$  v/m

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3. Accuracy of LVDT =  $\delta \text{displayed reading} / \text{displacement}(\text{micrometer}) * 100$

**Result:**

**Precautions:**

1. Handle all equipment with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.



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## EXPERIMENT NO. 2

**OBJECT:-** Measurement of Displacement using Magnetic(Inductive) Pickup.

**APPARATUS REQUIRED:-**

S. No.	Name of the equipment	Range/ Rating	Quantity	Type/ Made
1.	Variable Inductive Transducer kit		1	SIBA (INDIA)
2.	Multimeter		1	
3.	Connecting Wires		3 or 4	
4.				

**THEORY:-** The variable inductive transducer work on the same principle as of LVDT. A transducer if variable type consists of coil of ferromagnetic core. The displacement to be measured is applied to ferromagnetic target. This target does not have any physical contact with the core on which it is mounted. The core and target are separated by air gap. The displacement of the target allows change in inductive output voltage due to change in reluctance due to air gap.

**CIRCUIT DIAGRAM:-**

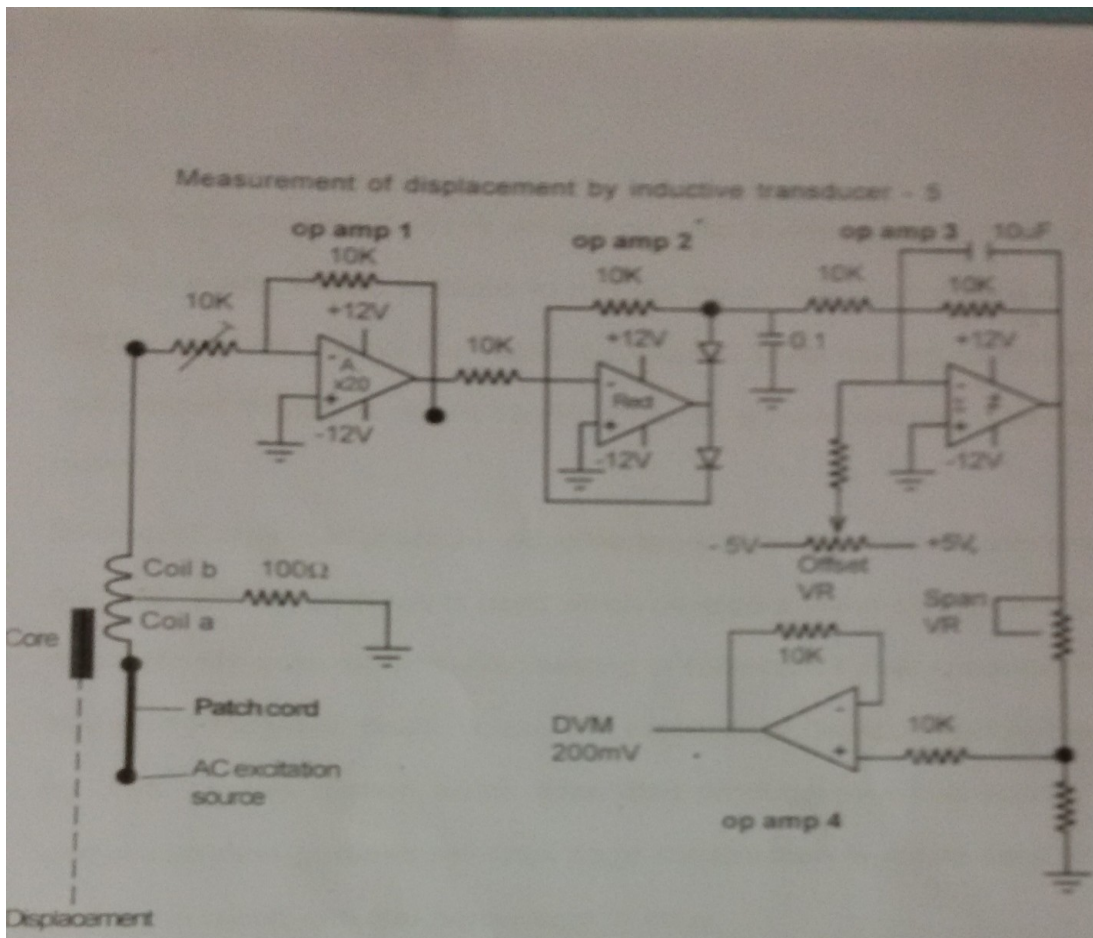


Fig 3. Circuit diagram for inductive transducer signal process.

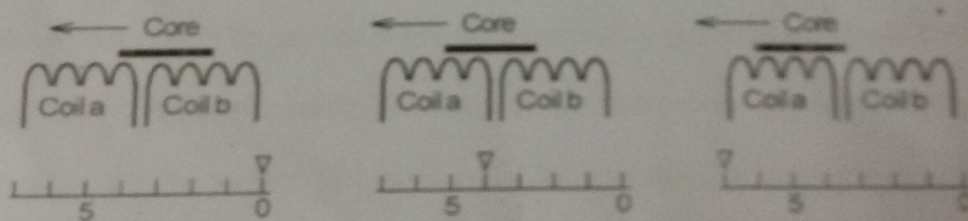


Fig 4. The core position in coil with displacement.

SATISH BROTHERS

AMBALA CANTT

## PROCEDURE:-

1. Connect the Multimeter into the kit and make sure that all the connections are tight.

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2. Set variable inductance knob on zero position and see there should not be any error.
  3. Now rotate the knob from zero, there is variation in Multimeter. Note the readings carefully.
  4. Repeat step 3 for five times.
  5. Make a graph between displacement and output voltage carefully.

**OBSERVATION TABLE:-**

S. No.	Displacement	Displacement Reading	Analog o/p

**RESULT:-** Resultant graph will be plotted between voltage and displacement.

**PRECAUTIONS:-**

1. Handle the equipment with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
4. The connections should be tight.

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## EXPERIMENT NO. 3

OBJECTIVE:- MEASUREMENT OF DISPLACEMENT USING STRAIN GAUGE

Apparatus Required:

S. No.	Name of Equipment	Range	Quantity	Type

Theory: This set up is designed to study of strain gauge utilization as displacement measuring transducers. The set up consists of Strain Gauge Bridge with small cantilever, micro meter for displacement, the signal conditioner circuit and a digital display calibrated for displacement measurement. The setup have its own inbuilt regulated DC supply. The complete system can be described in following manner.

- A) **Principle:** there are several electrical methods of measuring displacements. For example, one may use potentiometer, capacitive transducer or LVDT. However, it is possible to measure small displacement using strain gauge by converting displacement into force. This refers to the force applied above a point of cantilever; at one end has strain gauges to convert the strain into electrical voltages. The strain cantilever beam is used to measure the components of forces acting on a specimen. If load is imposed upon the direction 'f', the specimen is also subjected to stretch in direction 'm'. but since gauges 1,2 will be stretched to 'm' direction and 3,4 compress to inner side. Thus output voltage of the bridge is proportional to the bending only. He elastic constant of specimen feel stress and a change in length  $\Delta L/L$  will be the strain. The strain  $\epsilon$  is proportional to applied force and a change in bridge output voltage obtained as  $\Delta V$ .  $\Delta V$  is related with the strain and reference voltage  $V_r$ , as

$$\Delta V = \{(1 + \Delta R/R)/2 \times V_r\} \{(1 - \Delta R/R)/2 \times V\}$$
$$V_r = (V_r GF \epsilon)/2$$

Where GF is Gauge factor given as

$$GF = \{(\Delta R/R)/\epsilon\}.$$

Therefore bridge offset voltage due to force is, as

$$\Delta V = 2\{(R \cdot V_r/2R) - \{V_r(R + \Delta R) / (R + \Delta R) + R\}\}$$

Since  $V_r$ , and gauge factor GF is constant therefore the change in output voltage is proportional to change in strain, which is a function of applied pressure. a signal conditioner circuit is than employed to make the system useful to measure displacement .

- B) **THE SIGNAL CONDITIONER:** since first stage of signal conditioning is performed by the strain gauge bridge but it offer very low potential change as an measured  $\Delta V$ . further signal conditioning has an instrumentation amplifier, which not only offer high input impedance but also an amplification factor of (A1). To minimize the offset drift the gain is kept low otherwise it can be programmed for higher gains. The bridge offset is removed by adding an equal offset voltage in adder amplifier. Further amplification is done by next

amplifier A3 ( $A_v$  1-2, by mean of span) and output voltage is displayed at digital panel meter as displacement.

C) The strain gauge used in the set up : the technical specs of it is given below by manufacture

The resistance of strain gauge = 1200 $\Omega$

The gauge factor  $GF = 2.12 \pm 1\%$

Type FLA-6

Temp. Compensation:  $15 \times 10^{-4} / ^\circ\text{C}$

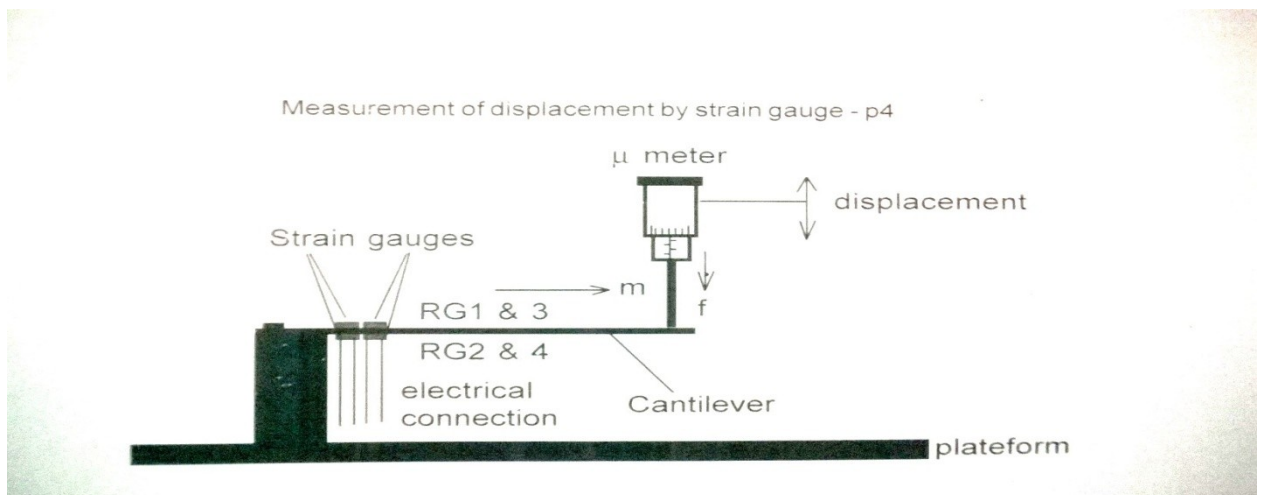
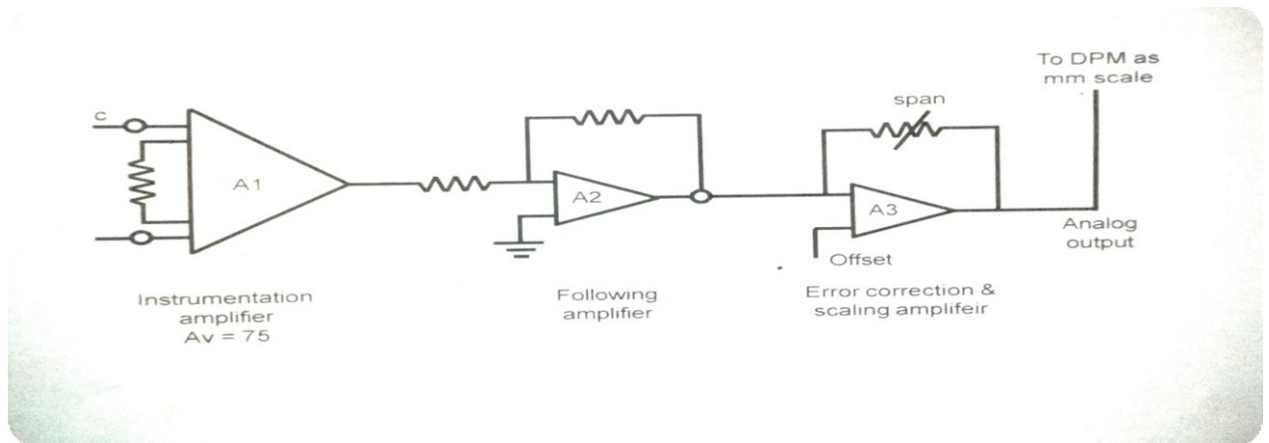
Transverse sensitivity: -0.2%

Gauge length: 6mm

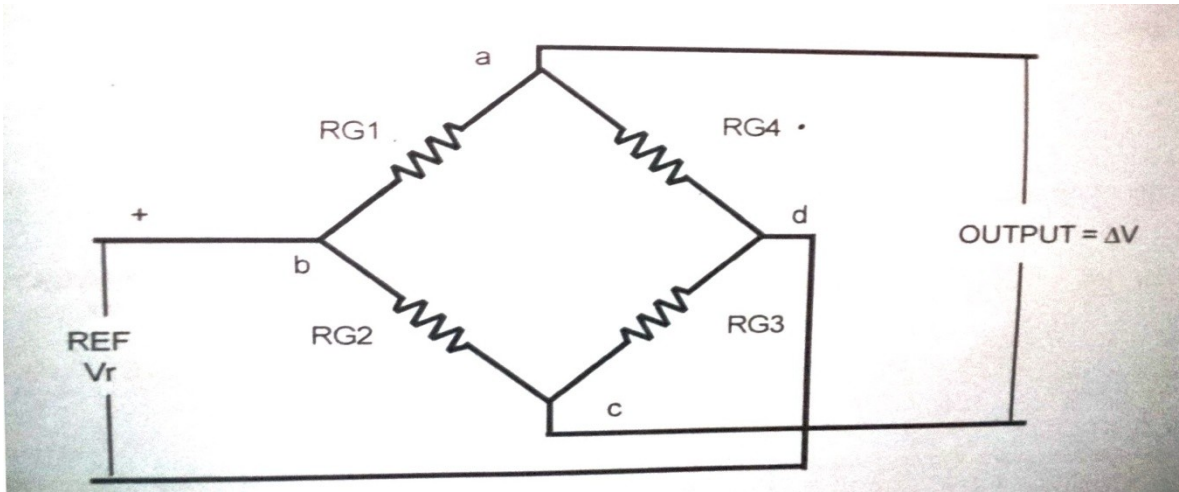
Test condition: 23 $^\circ\text{C}$  50% RH

The cantilever is made of stainless steel strip.

### Circuit Diagram:



Typical construction of stain cantilever construction.



Schematic Diagram of Strain Gauge Bridge.  $R=RG =120\Omega$

**Procedure:**

The unit: The unit is in the form of measuring displacement with the help of micrometer. Each turn is equal to 0.5mm.

Note: Adjusting the set up: Allow warm up time about 3 minute.

- Adjust micrometer to 0.0mm. Note in this position the force applied by micrometer is downward upon cantilever strip.
- Adjust the given offset control (ZERO Adjust) to bring 0.00mm in given display.
- Now bring micrometer 1mm outward (upward). Adjust the display reading 1.00mm with CAL ADJUST.
- Now move out the micrometer and note corresponding reading of mmeter displacement and displayed reading (-ve polarity shown as micrometer is going outward). Tabulate observations as shown in table 1
- Now from the table plot curve showing ammeter v/s displayed reading of displacement. The straight lines verify the experiment result.

**Observation Table:**

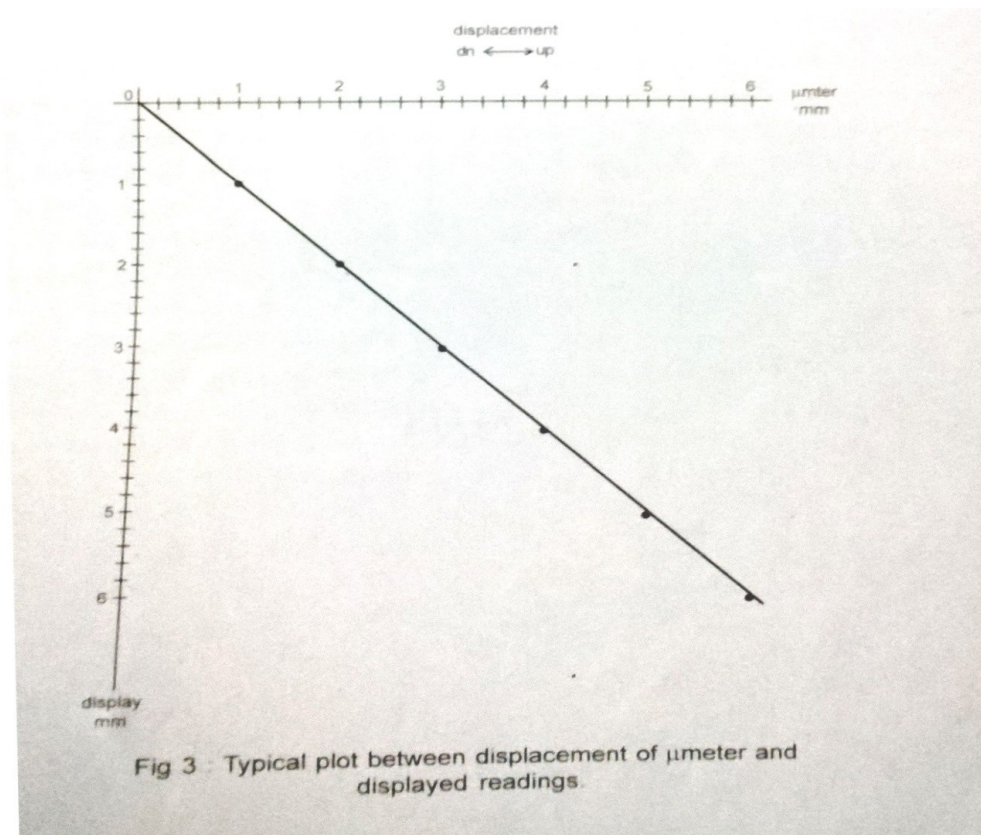
Micrometer reading(mm)	Display (mm)

**SOURCES OF ERROR:**

May be calibration (adjustment of zero adjust and 1.00mm CAL ADJUST 0 and micrometer backless.



## OUTPUT GRAPH:



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## EXPERIMENT NO. 4

**OBJECT:** Measurement of Load using Load Cell.

**APPERATUS REQUIRED:**

S. No.	Equipment Name	Rang/Rating	Quantity	Type/Mode
1.	Load cell with mount	10 kg	1	CZL-601
2.	Strain gauge bridge kit	-	1	SIL- 215
3.	CRO	-	1	-
4.	Power supply	220 V	-	-
5.	Connecting wires	-	2, 3	-
6.	Multimeter	-	1	-

**THEORY:**

A load is an electromechanical device which converts force into a electrical signal and use of measurement of static and dynamic forces. The load cell is a load receiving element having highly tensile strength and strain gauge which convert this change in formation or deform at – ion of load receiving element into proportional change in electrical signal. Construction wise the load has three basic parts, the housing (holding the cell), the load receiving element and strain gauge in bridge form.

In the load cell four strain gauges are mounted from which two sense compressive strain at the bottom side and tensile strain on the upper side. Since both the compressive and tensile strain is equal the bridge output twice. Connections are made to from four arm active bridge as shown in fig.1. The bridge is excited with a dc potential obtained from a band gap reference. The output of the bridge is fed to signal conditioner.

Since first stage of signal is performed by strain gauge bridge but it offers very low potential change (in  $\mu$  volts) as an measured signal. Further signal conditioning has an instrumentation amplifier, which not only high impedance but also an amplification factor of (A1). Further amplification is done by following amplifier A2 and output voltage is filtered by an active low pass filter having 2<sup>nd</sup> order with cut –off frequency 34Hz. Amplifier connection shown in fig.3.



**CIRCUIT DIAGRAM:**

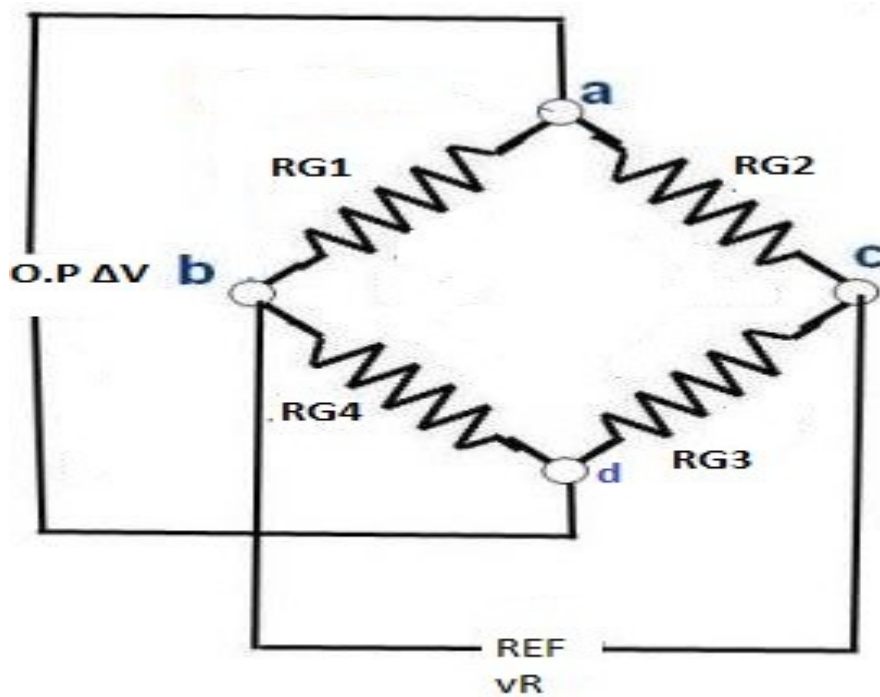


Fig.1: Circuit diagram of Strain Gauge Bridge.

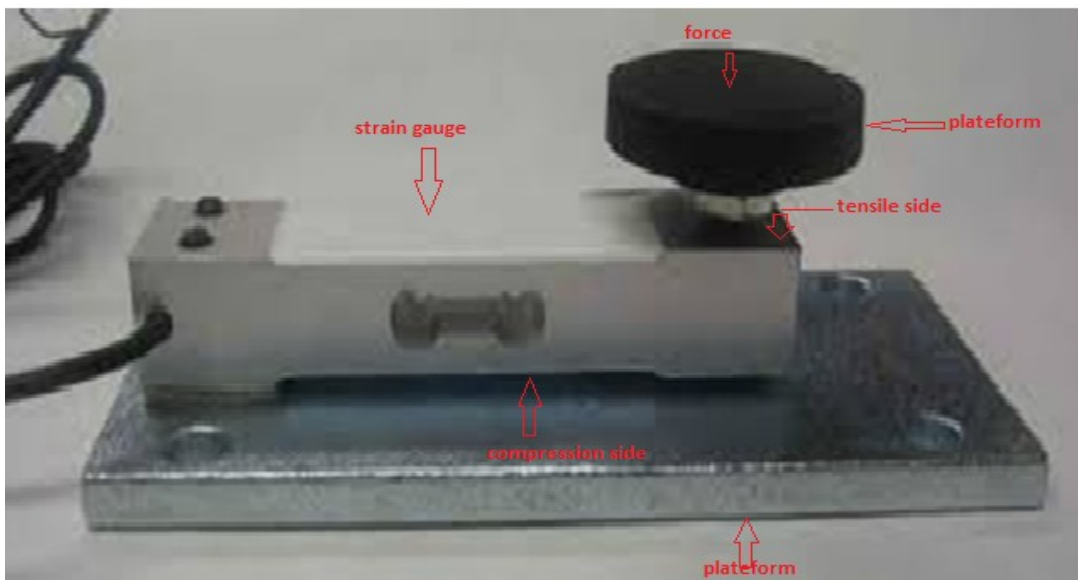


Fig.2: The construction of load cell with mount.

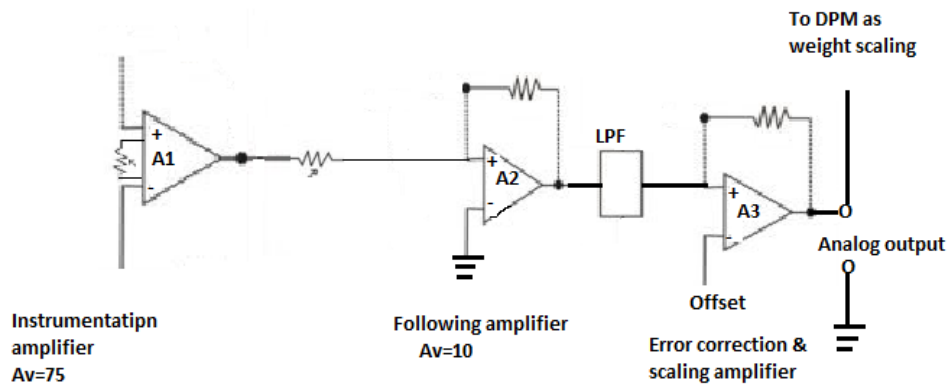


Fig.3: Block circuit diagram of load cell signal conditioner and application

**PROCEDURE:**

1. Connect the given load cell with the set up by of 5 pin connector.
2. Switch on the power. The readout will be glow. Wait about 3 min. for thermally stabilization.
3. Set zero control to made readout zero.
4. Now apply known load upon the load receiving platform centrally.
5. Adjust the spam control to read the output display as given weight in kg.
6. Lift up the weight from the load cell and if required re adjust zero control for zero readout.
7. Put the load (same weight) again and adjust spam to readout for same weight to display.

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**OBSERVATION TABLE:**

S. No.	Force (kg/ cm)	Van(volt)	$\Delta V(\text{volt})$
1.			
2.			
3.			
4.			
5.			

**CALCULATION:**

1. After making adjustment remove the load cell. Measure the dc voltage across bridge (between grnd. And ref.). Note the voltage as reference Vr.
2. Apply same weight of x kg upon the load cell. Note the voltage at analog amplifier output as v1.
3. Now increase weight of x kg at the platform. The total weight is 2x kg . Note the output at analog output socket as V2. From display reading it is observed that displayed value of weight is proportional to V1, V2..
4. Calculate the strain  $\epsilon$  as  
$$\epsilon = \Delta V / GF. Vr \text{ also } \Delta V = Van / Av$$
**or** 
$$\epsilon = 2[(Van / Av) / (GF.Vr)]$$
 where Av is amplifier voltage gains given 1200.
5. Apply different weight and plot the graph between applied weights and analog output or displayed value which should be straight line. It show the linear relation between transducer output  $\Delta V$  and force F(since Av is constant ,hence  $\Delta V= \Delta F$ ).

**RESULT:**

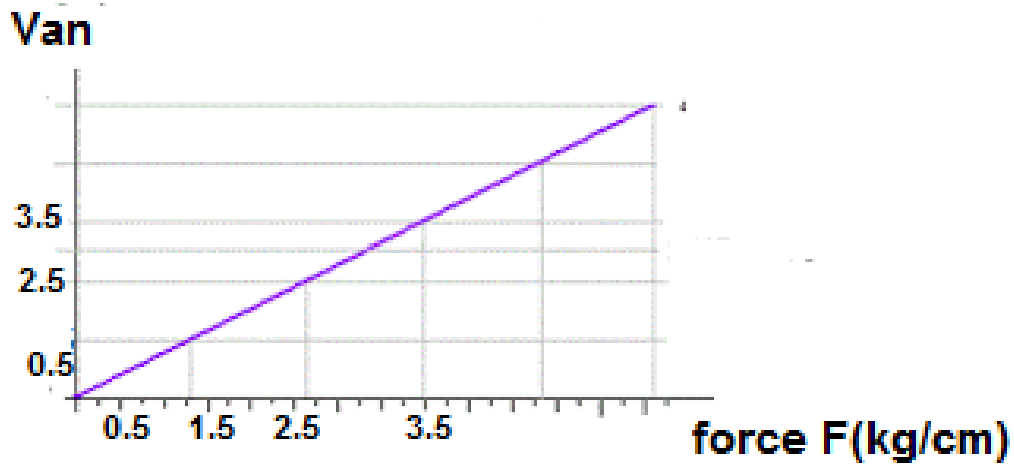
1. We get linear relation between force and Van.
2. we also get linear relation between force and  $\Delta V$ .

**PRECAUTION:**

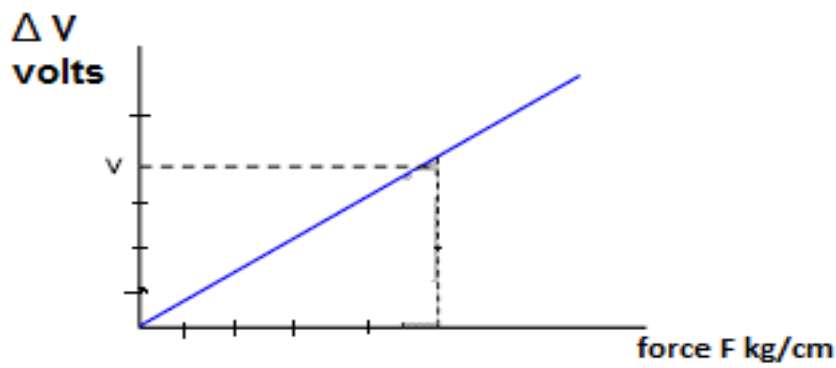
1. Pin connectors should be tight.
2. Zero and spam control are regulate carefully.

3. Take readings carefully.
4. Apply weight as procedure.

**GRAPH:**



Graphical relation between force and  $V_{analog}$ .



Graphical relation between force and  $\Delta V$

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## EXPERIMENT NO. 5

**OBJECT:** Measurement of air velocity using anemometer.

**APPARATUS REQUIRED:**

Sno.	Name of apparatus required	Range	Quantity	Type
1.	Anemometer		1	
2.	Unregulated DC motor		1	
3.	CRO		1	

**THEORY:**

Velocity is a vector quantity and defined as the rate of change of displacement and may be treated as air flow. The velocity can be measured by optical techniques if the displacement is linear function. one procedure called anemometer method. The set is based on two techniques 1. Transducer unit 2. Signal conditioner and measurement unit.

The anemometer:- when an axial mounted freely rotating cups ( 120° apart) is placed in path if air flow stream , impinging on the cups impart a force on the rotor in motion with angular velocity to air velocity when a steady rotational speed is reached the rotor speed at trained us proportional to volumetric rate of air flow the rotor disc diameter is 100 mm made of aluminium with 16 slots to interrupt light.

The optical unit: - it has an intense light emitting diode (L.E.D) and a photo diode mounted in a line. The light uniformly falls upon photo. Negative going pulse generated whenever it is interrupted. The slotted disc has 16 slots thus a single revolution if turbine causes to generate 16 pulses at the photo diode terminals.

**Signal Conditioner:-** the transducer output signal is poor in quality particularly at flow frequencies and very noisy in nature due to electric Field generated around the motor(fan). Before it send to counting chain it should be sufficient in amplitude and the noise level must be down to avoid false trigger if counter. To approach it comparator with hysteresis used for pulse shaping.

**The frequency scaling:-** the signal f, obtained from signal conditioner is proportional to rotation of turbine rotor. The f, should be multiplied by a constant n, before sending to count .The angular rotation of turbine rotor is given as

$$\omega R = (v/2\pi r)$$

Where  $v$  is the velocity of air,  $r$  is radius of rotor in meter. The frequency  $f$ , generated by opto-interrupter is proportional to angular velocity of rotor, hence

$$(f = \omega R)$$

$$(V = f \cdot 2\pi r) \quad \text{Meter/sec}$$

To display velocity in 4 digit scale counter the scaled be  $n$  times

$$n = (\text{scale}/f)2\pi r$$

Therefore  $f$  is multiplied by  $n = 20$

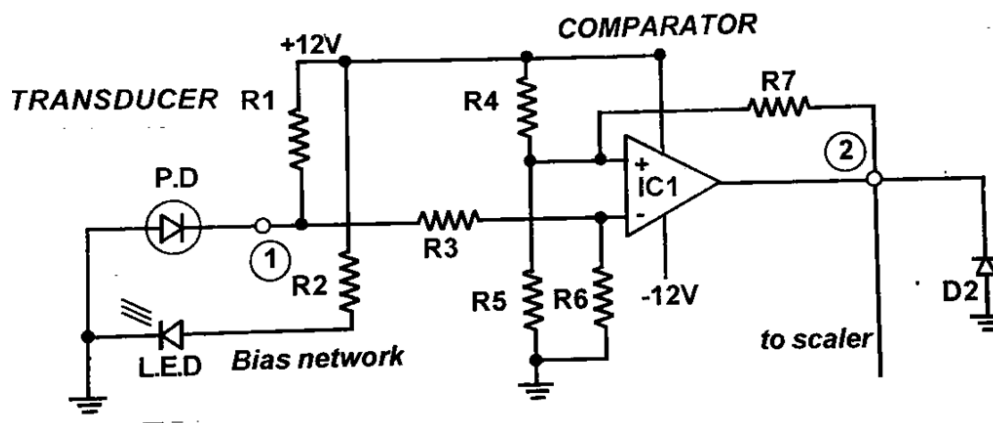
**PROCEDURE:**

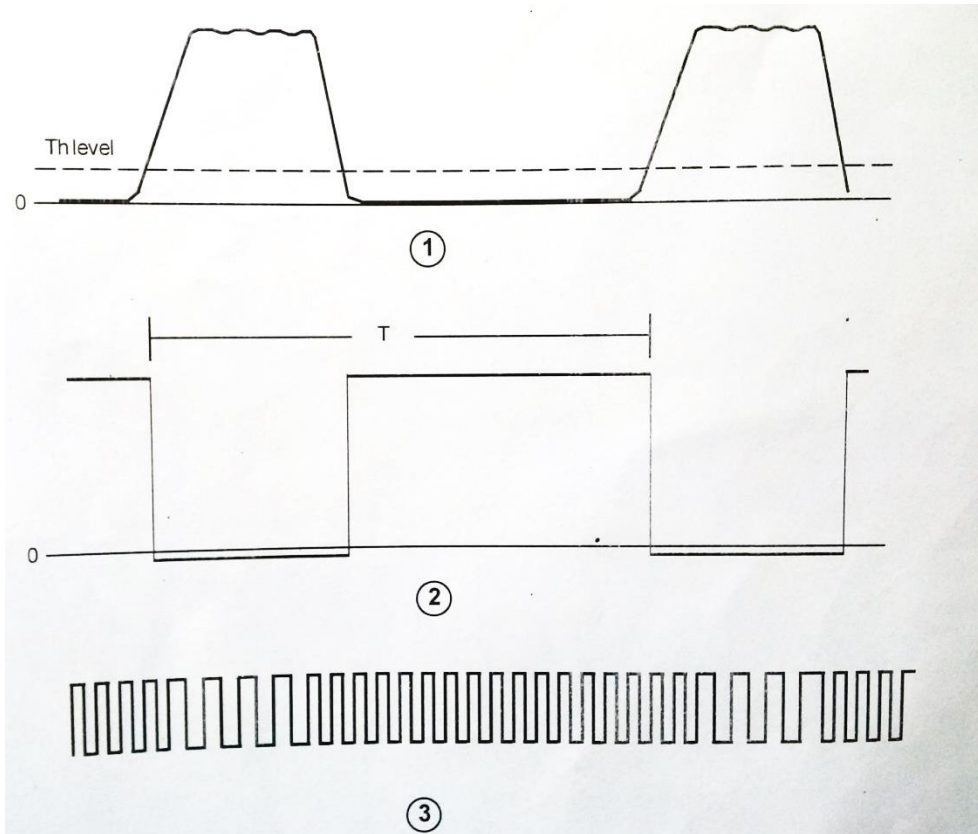
1. Connect the given motor plug with the main unit carefully
2. Insert the main's cord into the line outlet. Switch on the power.
3. As the anemometer get synchronized with air flow. Connect CRO at the transducer output socket fitted in main unit at 'transducer' block output. Observe the signal.
4. Connect CRO with pulse shaper output and observe the signal there. Note the shaping circuit clean up the pulses. There may be instability occurs, change the speed hi to lo or vice versa.
5. Connect CRO with scalar output and observe the number of pulses is  $n$  times of input.

Calculate the velocity of air,  $V'$ /km/hour, as  $V' = 3.6 V$

Where  $V$  is displayed value.

**CIRCUIT DIAGRAM:**





**OBSERVATION TABLE:**


**RESULT:**

The flow rate of air has determined by anemometer

**PRECAUTION:**

1. The connection should be in proper manner.
2. The motor used in this experiment is unregulated DC motor.
3. All the observation should be taken carefully.

## EXPERIMENT NO. 6

**AIM:-** (A) Study of Proportional Controller (P).

(B) Study of Proportional-Integral Controller (PI).

(C) Study of PID Controller.

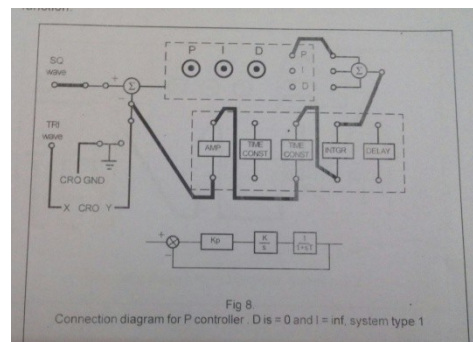
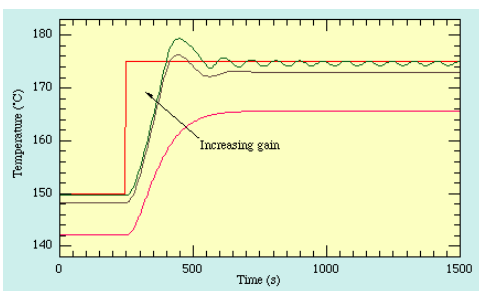
**APPARATUS REQUIRED:-**

S.No.	Name of the equipment	Range/Rating	Quantity	Type/Make
1.	PID Controller Kit	-	1	MODEL SCL 101
2.	Connecting wire	-	-	-
3.	Voltage Supply	-	1	-

**THEORY:-**

A. P Controller:-

A proportional controller attempts to perform better than the On-off type by applying power in proportion to the difference in temperature between the measured and the set-point. "In P controller, it is not possible to reduce the error ( $e_{ss}$ ) to zero". As the gain is increased the system responds faster to changes in set-point but becomes progressively underdamped and eventually unstable. The final temperature lies below the set-point for this system because some difference is required to keep the heater supplying power.



$$P(t) \propto e(t)$$

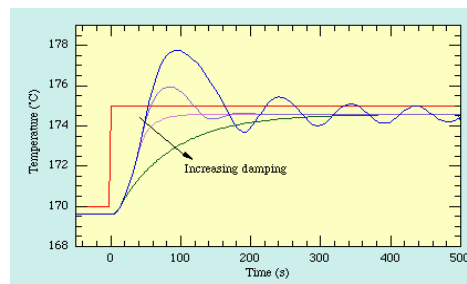
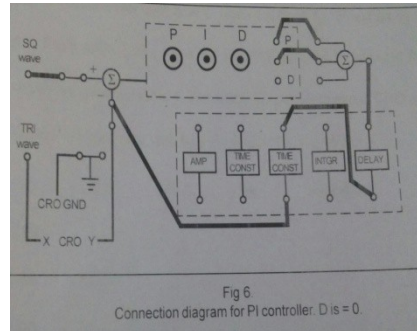
$$P(t) = K_p e(t)$$

$$(K_p = \text{slope of the line})$$



**B. PI Controller:-**

PI controller can maintain the stability of the system and also reduces the error ( $e_{ss}$ ). The Proportional-Integral (PI) algorithm computes and transmits a controller output (CO) signal every sample time, T, to the final control element (e.g., valve, variable speed pump). The computed CO from the PI algorithm is influenced by the controller tuning parameters and the controller error, e(t). PI controllers have two tuning parameters to adjust.

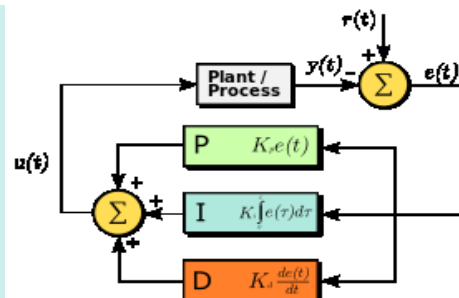
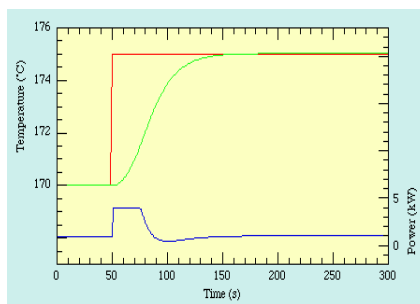


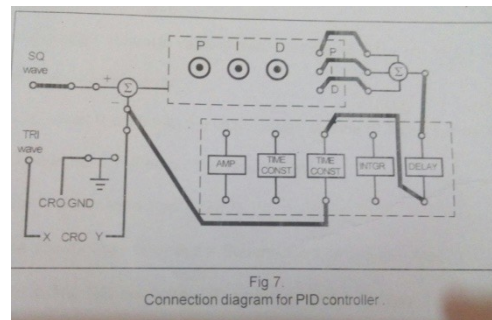
$$P(t) \propto [ e(t) + K_I \int e(t) dt ]$$

$$P(t) = K_p [ e(t) + K_I \int e(t) dt ]$$

**C. PID Controller:-**

Although PD control deals neatly with the overshoot and ringing problems associated with proportional control it does not cure the problem with the steady-state error. Fortunately it is possible to eliminate this while using relatively low gain by adding an integral term to the control function which becomes





$$P(t) \propto [e(t) + K_D \frac{de(t)}{dt} + K_I \int e(t) dt]$$

$$P(t) = K_P [e(t) + K_D \frac{de(t)}{dt} + K_I \int e(t) dt]$$

The transfer function of the PID controller can be written as,

$$(G) \text{ PID} = \frac{m(s)}{E(s)} = \frac{(Kd^2 + Kp(s) + Ki)}{s}.$$

### **PROCEDURE:-**

#### A. P Controller:-

1. Connect the circuit. Feed 1Vpp square wave input 20 Hz(50 mSec). Trigger CRO with the input signal. Keep CRO in CAL mode.
2. Trace the process reaction curve upon paper in regard with input. Find out the terms T and L.
3. Now close the loop. Switch over CRO for XY mode.
4. Adjust P control and note the X and Y values.
5. Find out the values of Kp at where the response observed oscillatory. It is the critical gain Kct.
6. Increase the Kp more thus the system generate oscillations.

#### B. PI Controller :-

1. Kp is set for 0.45 Kct, and Ki is adjusted for different values.
2. CRO in XY mode.
3. Adjust I Control.
4. Adjust P control.
5. The %overshoot =  $\frac{Y_{pp} - X_{pp}}{2}$ .
6. The steady state error  $e_{ss}$  = square wave amplitude -  $X_{pp}$ .

C. PID Controller :-

1. Set  $K_p = 7.5$  and  $K_i = 7.00$  (dial).
2. Adjust  $K_d$  from dial setting at 1.00 to 5.00 and tabulate the % os and  $e_{ss}$ .
3. Disconnect the integral and Derivative control leads.
4. The system is only with P controller.
5. Select the CRO for Trigger Mode.
6. Compute the transfer function and put the value of I and D.

**OBSERVATION TABLE :-**

A. P Controller :-

$K_p$	$X_{pp}$	$Y_{pp}$	Overshoot	$e_{ss}$

B. PI Controller :-

C. PID Controller :-

D dial	$K_D, s^{-1}$	$X_{pp}$	$Y_{pp}$	overshoot	$e_{ss}$

**MATHEMATICAL CALCULATION:-**

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A. P Controller :-

B. PI Controller :-

C. PID Controller :-

**RESULT:-**

A. P Controller:-

1. Oscillatory response at  $K_p = \dots\dots\dots = K_{ct}$ .
2. Sustained oscillation time at  $P_{ct} = \dots\dots\dots$
3. Switchover in CRO trigger mode and find out the period of oscillation as  $P_{ct}$  (time base must be in CAL mode).
4. The %overshoot =  $(Y_{pp} - X_{pp})/2$ .
5. The steady state error  $e_{ss}$  = Square wave amplitude -  $X_{pp}$ .

B. PI Controller :-

1. From table 2, the  $K_p$  is set for  $0.45 K_{ct}$ , and  $K_i$  adjusted for different values. The experiment is similar to the above experiment.
2.  $K_p = 0.45$

- 
3.  $K_{ct} = \dots\dots\dots$
  4. Adjust I control (0.833 Pct). Find out the % os and steady state error.
  5. Adjust P control and I control to a certain value. Find out the %os and ess.
  6. The %overshoot =  $(Y_{pp} - X_{pp})/2$ .
  7. The steady state error ess = Square wave amplitude  $-X_{pp}$ .
- C. PID Controller :-

**PRECAUTIONS:-**

1. All the connections should be tight.
2. The reading should be taken carefully and accurately.
3. Tracing should be done carefully and neatly.

## EXPERIMENT NO. 7

**OBJECT:** To study of thermocouple temperature sensor and to measure temperature of heating block

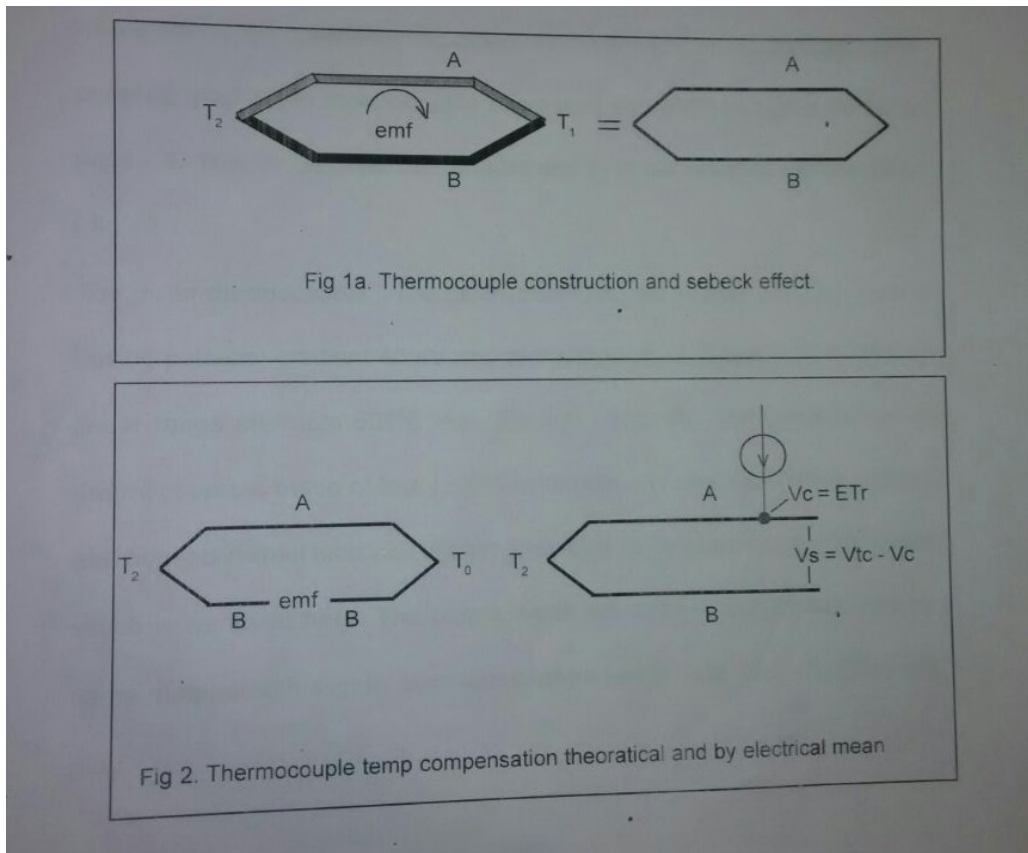
**APPARATUS REQUIRED:**

S. No.	Name of apparatus required	Range	Quantity	Type
1.	Thermocouple		1	Type j Tc- 28
2.	Transducer		1	
3.	Sensor		1	

**THEORY:**

In industrial control system information about physical process should be known and transducer play a vital role in it. Transducer is device that converts one form of energy into another. Thermocouple is widely used for measure temperature in industry.

Let two different metal A and B joined together at separate end connect joints are maintained at different temperature T1&T2.



$$e = T1/T2(Qa-Qb)dT$$

Where  $E_1$  is the end  $T_1$  &  $T_2$  are junction temperature and  $Q_a$  &  $Q_b$  are thermal constant the relation above called Seebeck effect.

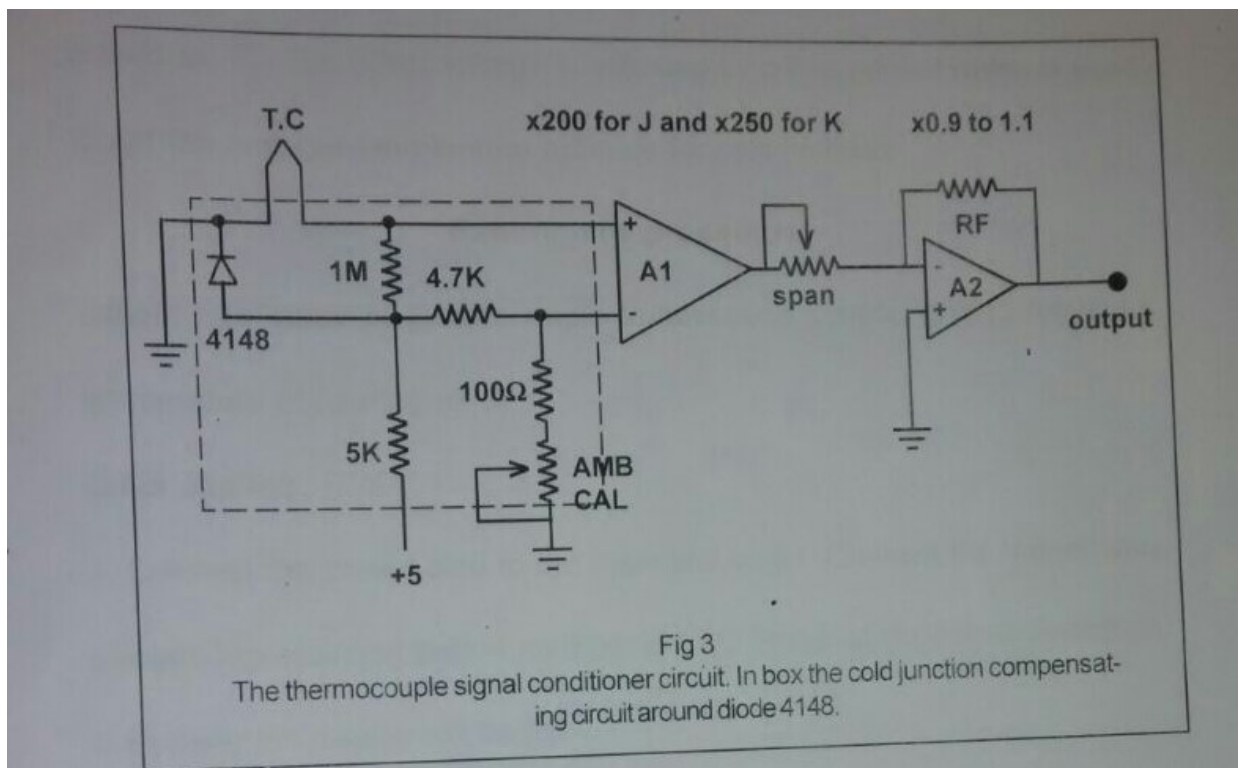
$$e = \alpha (T_2 - T_1)$$

$\alpha$  is constant and  $T_1$  &  $T_2$  junction temperature. The Seebeck effect as the basis of temperature sensor.

$$e = aT_2 + bT_1$$

$a$  &  $b$  are constant

The signal conditioner: - In the signal conditioner a cold junction temperature time compensation reference of differential amplifier have voltage gain  $30^\circ$ .

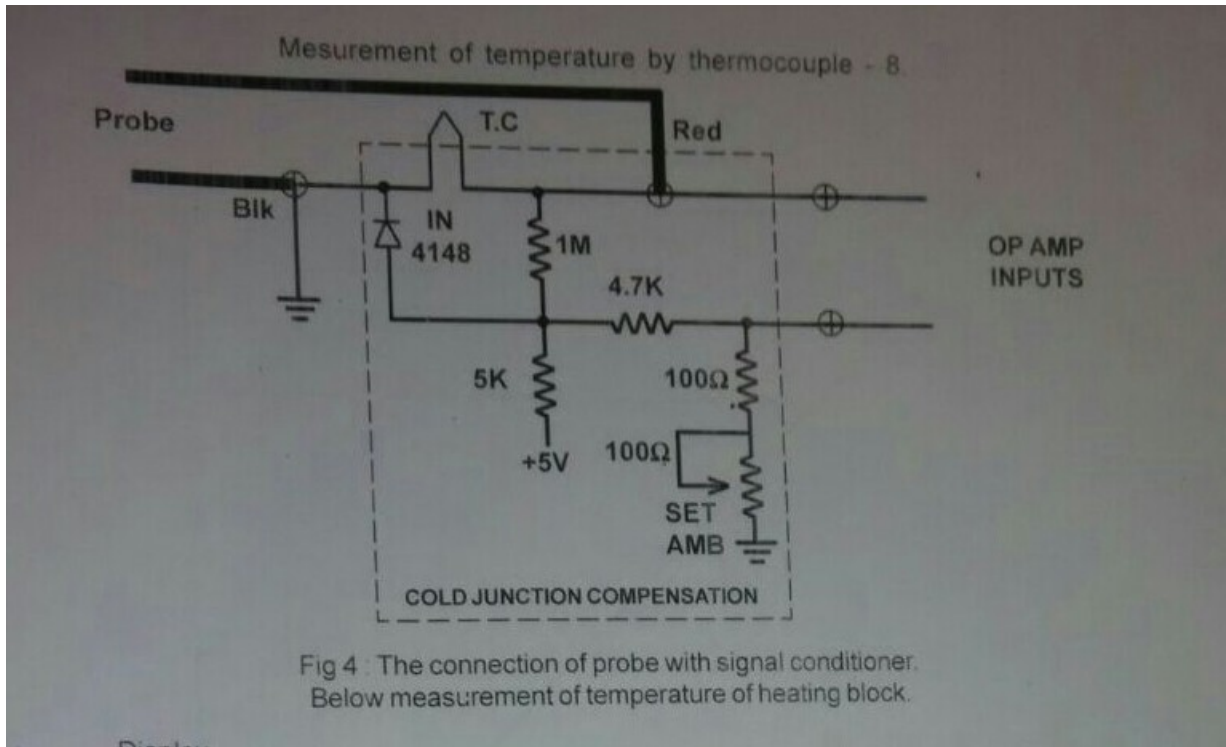


### PROCEDURE:

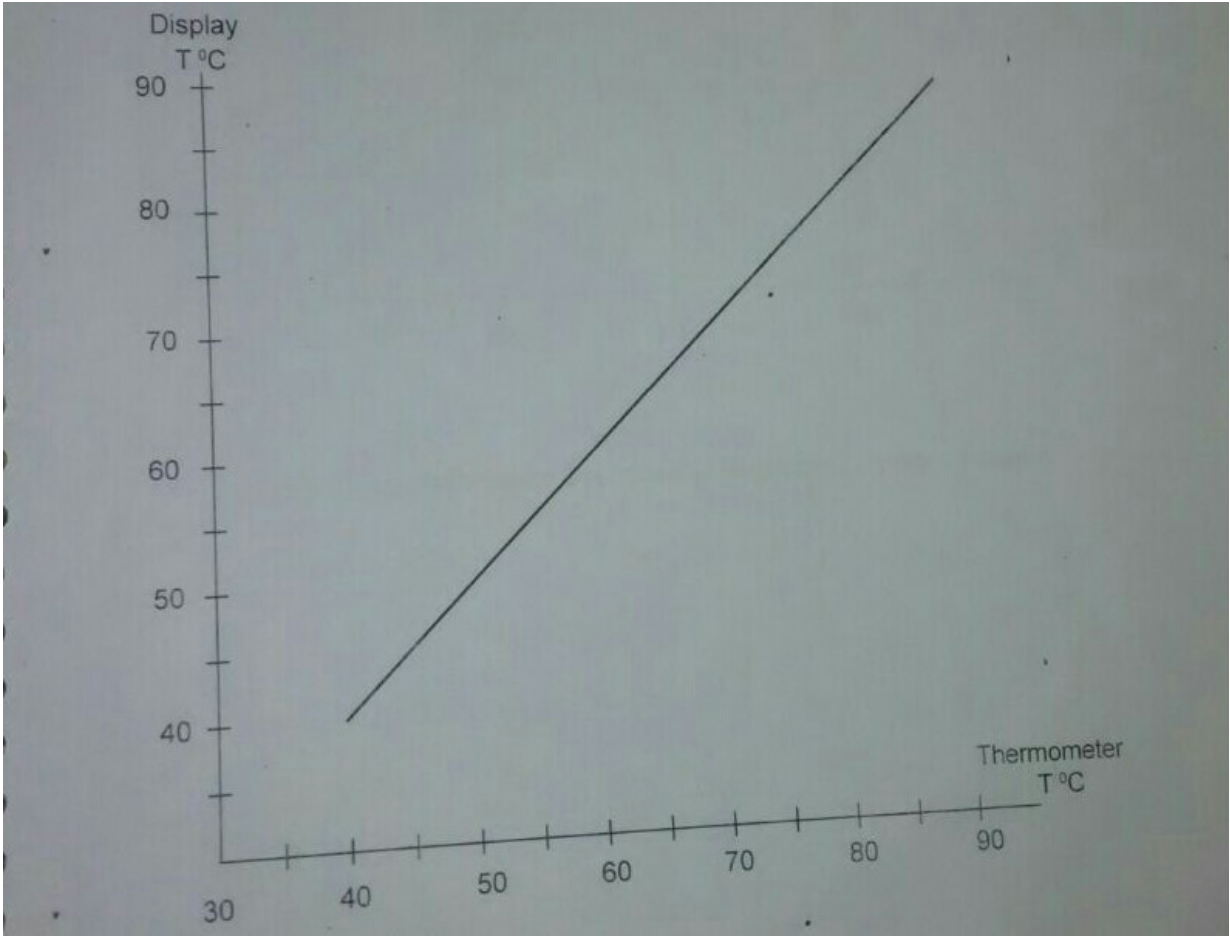
1. Connect the power cord to the main line outlet connect the thermocouple socket marked as Tc probe at the panel switch on the power the display.
2. Note the ambient temperature from the references thermocouple Meter keep span control adjust to midway it at given mark adjust control marked as set ambient to read display same temperature as shown by thermocouple.
3. Measure DC voltage across the analog output sockets as v2 at room temperature R, C with DMM.
4. Switch on heater put the T-C probe in the hole of heating block.

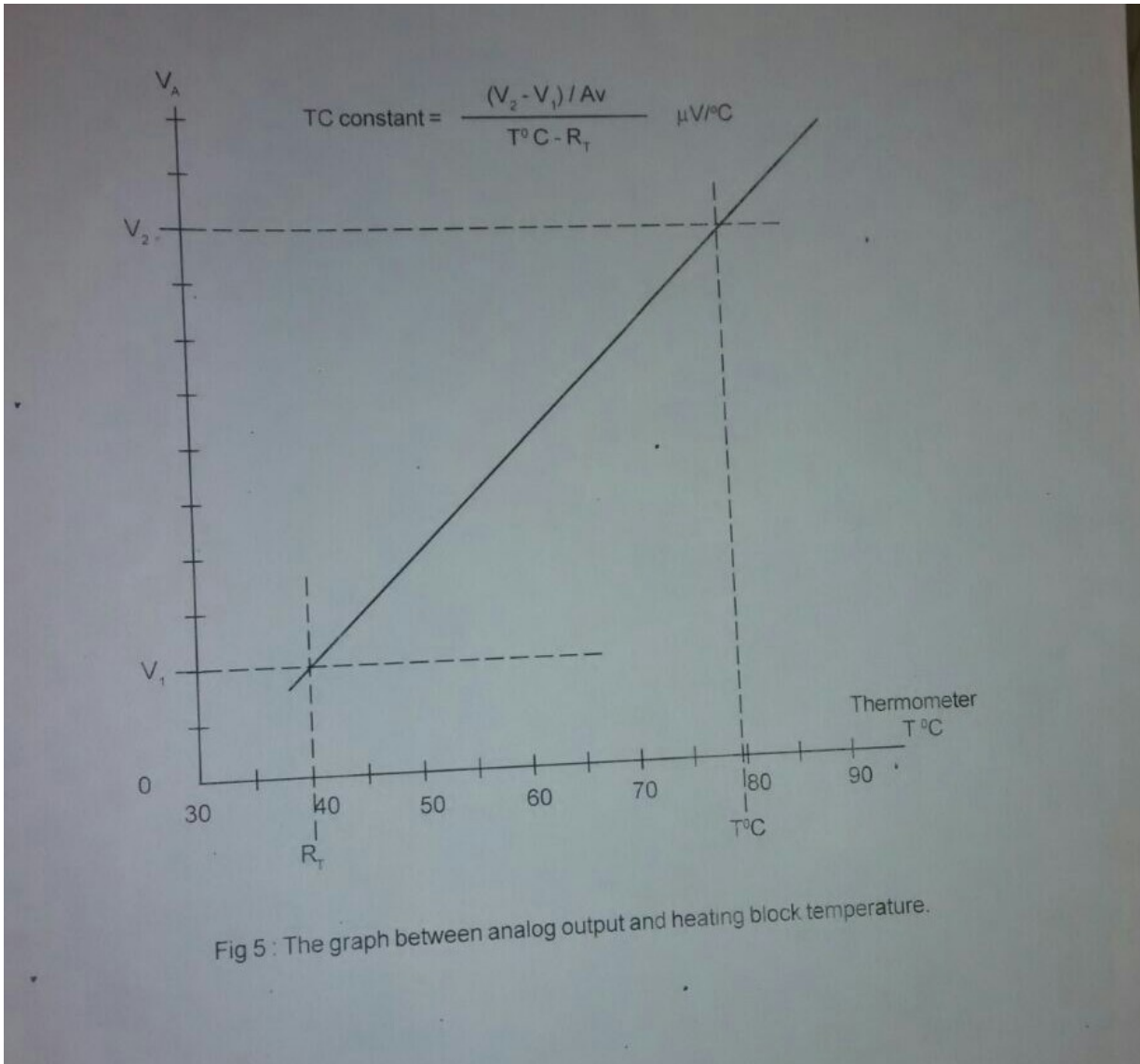
5. As the temperature rise the temperature between display and reference temperature thermometer start rising. After some time temperature rise nearly  $90^\circ$ .
6. Switch off heater a look little time latter temperature become stable note reference thermometer temperature and adjust 'span' control equal to read display the some temperature.
7. Plot the curve between display temperature and the reference temperature the curve show straight line show the curve is linear transfer nature of thermocouple.

**CIRCUIT DIAGRAM:**









**OBSERVATION TABLE:**

Reference temperature	Display temperature	Va

**RESULT:** By comparing display temperature and reference temperature plot curve and find a temperature of a heating block.

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**PRECAUTION:**

1. The connection should be in proper manner.
2. Observation should be taken on the room temperature.
3. All the observation should be taken carefully.