1. MEASUREMENT & CALIBRATION OF DISPLACEMENT USING LVDT

**AIM:** To measure the displacement using LVDT.

**APPARATUS:**

1. LVDT Setup
2. Resistors – 4.7KΩ-3, 10KΩ
3. Signal generators
4. Digital multi-meter

**DESCRIPTION:**

The linear variable differential transformer is an inductance variable type displacement transducer. It consists of three coils, one primary and two secondary, all in a linear arrangement, with a magnetic core free to move inside the coils. The core is normally made of nickel iron alloy and has a longitudinal slot for reducing eddy currents. Ferrite cores are also being used now for less loss and larger sensitivity. The core is positioned with a non-magnetic rod. The primary is supplied with an alternating voltage of amplitude between 5 and 25 volts and frequency 50Hz to 20 KHz. The secondary are connected in phase opposition, so that the output is zero. This assumes that there is no transverse displacement also of the core. The output is linear with core displacement over a wide range but under goes a phase shift of 180˚ when the core passes through the zero displacement position i.e.; the central location. There is a residual voltage of 1% or less of the maximum linear voltage at zero displacement. This in complete imbalance is attributes to the stray magnetic and capacitive coupling between the primary and the secondary and presence of harmonic components.
CIRCUIT DIAGRAM:

PROCEDURE:

1. Connection are made as per circuit diagram
2. Initially setup core of LVDT at center
3. Minimize the residual voltage with external balance circuit
4. Change the core displacement 1 mm in one direction and observe the corresponding output voltage in DMM/CRO
5. Repeat the step 4 until then displacement is 10 mm and observe the corresponding voltage for various displacement in steps
6. The core is moved forwards in other direction and take the reading for various displacements in steps

A) Measurement:
   Residual voltage  - 3.2mv
   Minimum voltage  - 0.7mv
**Color code:**
Red & green / shield: Primary
Yellow & green, center black: Secondary

**MODEL OF EXPERIMENTAL RESULTS:**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>DISPLACEMENT (mm)</th>
<th>O/P VOLTAGE (mv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.7</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>9.1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>17.9</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>26.3</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>35.4</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>44.6</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>33.7</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>63.3</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>72.8</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>81.8</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>91.0</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>16.9</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>23.5</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>34.4</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>42.8</td>
</tr>
<tr>
<td>17</td>
<td>6</td>
<td>52.4</td>
</tr>
<tr>
<td>18</td>
<td>7</td>
<td>62.48</td>
</tr>
<tr>
<td>19</td>
<td>8</td>
<td>71.5</td>
</tr>
<tr>
<td>20</td>
<td>9</td>
<td>80.5</td>
</tr>
<tr>
<td>21</td>
<td>10</td>
<td>90.2</td>
</tr>
</tbody>
</table>
**B) CALIBRATION:**

a) Initially set the core of an LVDT at center position and observe the residual voltage at null position.

b) Now rotate the 10Kohm pot and observe the voltage in DMM such that it should be lowest reading which is approximately (0.6mv to 1.3mv)

**TABULAR FORM:**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>DISPLACEMENT in mm</th>
<th>O/P VOLTAGE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LEFT</td>
<td>RIGHT</td>
</tr>
</tbody>
</table>

**MODEL GRAPH:**

![Graph Image]

**RESULT:**

- Residual voltage = ------mv
- Minimum voltage = ------mv
- Linear displacement range =------mm
PRE EXPERIMENTAL QUESTIONS:
1. What are the different types of transducers used for displacement measurements?
2. What is the difference between variable resistance and variable inductance displacement transducer?
3. Explain about synchros and resolvers?
4. Explain about LVDT basic construction and connection of secondary winding?
5. List few advantages of the LVDT type of displacement sensors?
6. Define the term residual voltage?
7. Define the characteristics of LVDT (such as Range, Linearity, Temperature range etc)?
8. What is the i/p voltage applied for the LVDT?
9. How can you measure the angular displacement?
10. How can you measure the displacement by using Hall effect?

POST-EXPERIMENTAL QUESTIONS:
1. What is residual voltage applied from your experiment?
2. How can you identify the center of LVDT?
3. What is the min voltage you can obtain by adjusting the null balancing circuit?
4. Define the range of displacement and range of voltage of your experiment?
5. How can you obtain the Ac signal with different frequencies such as 2 K Hz – 10 K Hz with different amplifiers?
6. Describe the color code of LVDT?
7. What is the linear displacement range of LVDT?
8. What is the difference between LVDT and RVDT?
9. Is it possible to measure stress by using LVDT?
10. Analyze the results.
2. MEASUREMENTS AND CALIBRATION OF TEMPERATURE

**AIM:** To study the characteristics of the resistance temperature detector and plot the Resistance verses temperature characteristics

**APPARATUS:**
1. RTD – PT100
2. Temperature setup
3. Temperature indicator
4. DMM

**DESCRIPTION:**

A metallic resistance element changes it’s resistance with temperature in a much specified manner. Pure element has been used for measurement of temperature by this effect and the method is one of the most accurate ones. Electrical conductivity of a metallic element is given by

\[ \sigma = ne^2t_r/M \]

Where, 
- \(e\) - Electron charge
- \(n\) - No of electrons for unit volume
- \(M\) - Mass of electron
- \(t_r\) - Relaxation time

The relaxation between resistance and temperature change \(\Delta t\) is

\[ R_t = R_0 \{1+\alpha_1\Delta t\} \]

The commonly used metal is platinum with a range -190° to 660° international scale with second degree relation. At a range below 120K, a gold silver alloy has been tried and it has been seen to have characteristics similar to platinum.

The resistance thermometers are protected from the medium being measured by encasing tubes. RTD have resistance varying from 0.1 to a few 100 ohms. Resistance thermometers are the most accurate of all the temperature measuring systems and an accuracy of 0.0001°C can be obtained. They are very convenient for measurement of a small temperature difference.
PROCEDURE:

1. Initially measure the resistance of RTD in steam bath as show in figure
2. Place the RTD and temperature indicator in steam bath as shown in the figure
3. Switch on the supply and measure the resistance of the RTD for corresponding rise in temperature in steps of 5°C
4. Switch of the steam bath when steam temperature rises to 100°C
5. Now allow the steam to cool at normal value and measure the resistance for corresponding fall of temperature in steps of 5°C
6. Calculate the difference in resistance at corresponding temperature
7. Plot the graph of resistance verses temperature and plot the graph of error verses temperature
MODEL OF EXPERIMENTAL RESULTS:

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>TEMPERATURE</th>
<th>DMM in volts (-ve voltage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>86</td>
<td>0.87</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>0.811</td>
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<tr>
<td>3</td>
<td>75</td>
<td>0.75</td>
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<tr>
<td>4</td>
<td>70</td>
<td>0.69</td>
</tr>
<tr>
<td>5</td>
<td>65</td>
<td>0.64</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>0.59</td>
</tr>
<tr>
<td>7</td>
<td>55</td>
<td>0.56</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>0.51</td>
</tr>
<tr>
<td>9</td>
<td>45</td>
<td>0.46</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>0.39</td>
</tr>
<tr>
<td>11</td>
<td>35</td>
<td>0.34</td>
</tr>
</tbody>
</table>

CALIBRATION:

a) Adjust 10KΩ pot (ten turn pot) such that “Vo” should adjust to room temperature.

b) Start heater and stop at 90°C then adjust the 47KΩ such that it should equal to maximum temperature

MODEL GRAPH1:

![Graph](attachment:graph.png)

Resistance in ohms

Temp deg / C
MODEL GRAPH2:

OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>TEMPERATURE IN °C</th>
<th>RISING TEMP RESISTANCE</th>
<th>FALLING TEMP RESISTANCE</th>
<th>ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS: MAX ERROR -------

MIN ERROR -------
PRE EXPERIMENTAL QUESTIONS:
1. Define temperature?
2. List different types of temperature transducers?
3. What is a thermister, how is it used for temperature measurement?
4. What are the limitations of thermister?
5. Briefly explain about thermocouples?
6. List and explain about three laws of thermocouples?
7. What are the common materials used for thermocouples?
8. What is a thermopile?
9. How can you measure the temperature in boilers?
10. What are the materials used for manufacturing thermister?

POST-EXPERIMENTAL QUESTIONS:
1. What is the resistance of your thermister at room temperature?
2. How you have placed a thermister on your water tub?
3. How can you set the minimum voltage or temperature in your circuit diagram?
4. Explain how you can adjust the maximum voltage in your circuit diagram?
5. How many iteration it has taken for calibration?
6. Explain in what way you reduced your water temperature?
7. What is meant by Pt-100?
8. What are the materials used to make RTD?
9. What is meant by thermo bole?
10. Finally analysis your results?
3. MEASUREMENT AND CALIBRATION OF PRESSURE

AIM: To measure the pressure variable using process station

APPARATUS:

1. Pressure station
2. Stop watch
3. 5V regulated power supply

DESCRIPTION:

Measurement of pressure is of considerable importance in process industries. Most of these pressure ranges from below atmosphere above atmosphere. Primary sensors are mostly mechanical which through secondary sensing means provide electrical output. Here control valve is operated in direct mode, which means control valve closes while error voltage decreases.

BLOCK DIAGRAM:
PROCEDURE:
1. Switch all the parameters, take the input pressure with the aid of compressor
2. Regulate the supply pressure to a constant value of 20 PSI
3. Apply the input signal in the form of analog voltage signal as an input to the I–V converter
4. O/P of V/I take as an input to the I/P converter to drive the pneumatic control valve
5. Record the pressure build in the chamber w.r.t to time

MODEL OF EXPERIMENTAL RESULTS:

<table>
<thead>
<tr>
<th>TIME IN Sec</th>
<th>PRESSURE IN TANK (PSI)</th>
<th>VOLTAG E1.5V</th>
<th>VOLTAG E2.5V</th>
<th>VOLTAG E3.5V</th>
<th>PRESSURE INDICATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>0.7 Kg/sq.cm</td>
</tr>
<tr>
<td>2.</td>
<td>20</td>
<td>20</td>
<td>19</td>
<td>18</td>
<td>1.2 Kg/sq.cm</td>
</tr>
<tr>
<td>3.</td>
<td>30</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>1.7 Kg/sq.cm</td>
</tr>
<tr>
<td>4.</td>
<td>40</td>
<td>41</td>
<td>41</td>
<td>41</td>
<td>2.2 Kg/sq.cm</td>
</tr>
<tr>
<td>5.</td>
<td>50</td>
<td>57</td>
<td>54</td>
<td>55</td>
<td>2.7 Kg/sq.cm</td>
</tr>
<tr>
<td>6.</td>
<td>60</td>
<td>67</td>
<td>68</td>
<td>67</td>
<td>3.1 Kg/sq.cm</td>
</tr>
<tr>
<td>7.</td>
<td>70</td>
<td>76</td>
<td>87</td>
<td>89</td>
<td>3.5 Kg/sq.cm</td>
</tr>
<tr>
<td>8.</td>
<td>80</td>
<td>86</td>
<td>120</td>
<td>130</td>
<td>3.7 Kg/sq.cm</td>
</tr>
</tbody>
</table>

CALIBRATION:

a) Calibration of V/I converter by using ammeter 0V - 4mA and 5V – 20mA
b) Maintain the pressure gauge NO-3 to 20Psi.
c) Maintain the pressure gauge NO-1 to 30Psi.
d) Calibration of pressure indicator by using min and max position
MODEL GRAPH:

![Graph showing pressure vs. time for different voltages](image)

pressure in Psi

**OBSERVATION TABLE:**

<table>
<thead>
<tr>
<th>SL.N O</th>
<th>PRESSURE IN TANK (PSI)</th>
<th>TIME IN Sec</th>
<th>VOLTAG E1.5V</th>
<th>VOLTAG E2.5V</th>
<th>VOLTAG E3.5V</th>
<th>PRESSURE INDICATED</th>
</tr>
</thead>
</table>

**RESULTS:**

1. Average time for 10 PSI when I/P Voltage is 1.5 V =
2. Average time for 10 PSI when I/P Voltage is 2.5 V =
3. Average time for 10 PSI when I/P Voltage is 3.5 V =
PRE EXPERIMENTAL QUESTIONS:

1. What are the units of pressure?
2. Define difference between atmospheric pressure and absolute pressure?
3. List few applications of pressure measurement?
4. What is the difference between gauge pressure and vacuum pressure?
5. Name two instruments used to measure low pressure?
6. How an elastic diaphragm gauge is used to measure pressure?
7. What is dynamic or impact pressure?
8. How a dead weights tester is used to calibrate pressure-measuring device?
9. Define bourdon tube pressure gauge?
10. Define bellows gauge, strain gauge used to measure pressure?

POST-EXPERIMENTAL QUESTIONS:

1. Define the maximum pressure you can measure in your experiment?
2. What is the relation between voltage and current in your experiment?
3. Explain the relation between current and pressure in your experiment?
4. What is the average time taken to fill the pressure in PSI for 25%, 50% of control value?
5. What is the technique used for pressure measurement in your experiment?
6. How can you reduce the error between actual and indicated measurement of pressure?
7. Explain how controlling i/p voltage can control pressure in your workstation?
8. How pressure is converted into electrical signals in your workstation?
9. What is the range of pressure applying for control value from I/P converter?
10. Finally analyze your results.
4. MEASUREMENT AND CALIBRATION OF LEVEL

AIM: Measurement of liquid level for varying flow rates

APPARATUS:
1. Level station
2. Stop watch
3. 5V regulated power supply
4. Air compressor

DESCRIPTION:

The column exerts over a datum level or in terms of the length of the liquid column. Liquid level may be measured by direct methods such as point contact method, gauge glass or sight glass techniques or by indirect methods such as by measuring the hydrostatic pressure of the liquid column. For clean and colored liquids, the simplest types of sight glass or gauge glass techniques are used. It usually gives a local indication.

The sight glass tube is a side glass tube to the tank whose diameter should neither be large enough to reduce the tank liquid level by appreciable percentage nor small enough to initial capillary action in the tube. Capillary action raises the water level in the sight tube by about 0.1/d, where d is the inner diameter of the tube in Cm.

Measurement of liquid level is quite important in a variety of industrial process. The liquid level may be expressed in terms of the pressure
PROCEDURE:

1. Drain out the water from the tank and close the outlet valve 100%.
2. Give the input supply to the setup from the compressor.
3. Regulate the input supply to an order of 20 PSI using air regulator.
4. Apply the input signal in terms of an analog voltage signal and make all the necessary connections in order to drive the pneumatic control valve.
5. Record the reading of the level parameter in cm w.r.t to time in sec.
6. Repeat the experiment for different flow rates.
## MODEL OF EXPERIMENTAL RESULTS:

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>LEVEL IN Cm</th>
<th>FLOW RATE 200 LPH</th>
<th>FLOW RATE 400 LPH</th>
<th>FLOW RATE 600 LPH</th>
<th>LEVEL INDICATED IN Cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>5Cm</td>
<td>65Sec</td>
<td>40 Sec</td>
<td>25 Sec</td>
<td>0.06M</td>
</tr>
<tr>
<td>2.</td>
<td>10 Cm</td>
<td>60 Sec</td>
<td>30 Sec</td>
<td>25 Sec</td>
<td>0.11 M</td>
</tr>
<tr>
<td>3.</td>
<td>15 Cm</td>
<td>60 Sec</td>
<td>35 Sec</td>
<td>25 Sec</td>
<td>0.15 M</td>
</tr>
<tr>
<td>4.</td>
<td>20 Cm</td>
<td>55 Sec</td>
<td>40 Sec</td>
<td>25 Sec</td>
<td>0.19 M</td>
</tr>
<tr>
<td>5.</td>
<td>25 Cm</td>
<td>60 Sec</td>
<td>45 Sec</td>
<td>28 Sec</td>
<td>0.24 M</td>
</tr>
<tr>
<td>6.</td>
<td>30 Cm</td>
<td>60 Sec</td>
<td>35 Sec</td>
<td>25 Sec</td>
<td>0.29 M</td>
</tr>
<tr>
<td>7.</td>
<td>35 Cm</td>
<td>60 Sec</td>
<td>40 Sec</td>
<td>26 Sec</td>
<td>0.33 M</td>
</tr>
<tr>
<td>8.</td>
<td>40 Cm</td>
<td>60 Sec</td>
<td>35 Sec</td>
<td>24 Sec</td>
<td>0.37 M</td>
</tr>
<tr>
<td>9.</td>
<td>45 Cm</td>
<td>60 Sec</td>
<td>40 Sec</td>
<td>25 Sec</td>
<td>0.41 M</td>
</tr>
<tr>
<td>10.</td>
<td>50 Cm</td>
<td>60 Sec</td>
<td>40 Sec</td>
<td>24 Sec</td>
<td>0.46 M</td>
</tr>
</tbody>
</table>

a) Average time for 5Cm when flow rate 200LPH = 60Sec
b) Average time for 5Cm when flow rate 400LPH = 38Sec
c) Average time for 5Cm when flow rate 600LPH = 25.2Sec

### CALIBRATION:

1. Calibration of V/I converter by using milli ammeter adjusts knob at 0V=4mA and 5V=20mA.
2. Adjustment of pressure gauge NO-3 to 20Psi.
3. Maintain the pressure gauge NO-1 to 30Psi.
MODEL GRAPH:

Level

OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>LEVEL IN Cm</th>
<th>FLOW RATE 200 LPH</th>
<th>FLOW RATE 400 LPH</th>
<th>FLOW RATE 600 LPH</th>
<th>LEVEL INDICATED IN Cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULT:
1. Average time for 5Cm when flow rate 200LPH =
2. Average time for 5Cm when flow rate 400LPH =
3. Average time for 5Cm when flow rate 600LPH =
PRE EXPERIMENTAL QUESTIONS:

1. What is liquid level?
2. Define difference between direct and indirect liquid level measuring devices?
3. How can gamma rays be used to measure liquid level?
4. Explain the principle behind electric liquid level sensors?
5. What are the sensors used to measure liquid levels in metal and non-metallic tanks?
6. How can you measure the liquid level in conductive and non-conductive liquids?
7. What are the different liquid level sensors?
8. How hydrostatic pressure can be used for measuring liquid level?
9. What is the difference between bubbler and purge system?
10. What are the advantages and disadvantages of slight glass method?

POST-EXPERIMENTAL QUESTIONS:

1. Explain about V/I converter?
2. How much pressure you have to maintain as i/p for I/P converter?
3. What is the average time taken for to fill 5cm level at 200LPH-flow rate?
4. How can you control valve opening?
5. What is the technique used for level measurement in your experiment?
6. How can you reduce the error between actual and indicated measurement of level?
7. Explain about the precaution taken for controlling the float rate?
8. What is the range of pressure applying for control value from I/P converter?
9. How level is converted to electrical signal?
10. Finally analyze your results.
4. MEASUREMENT OF FLOW

AIM: To measure the flow water

APPARATUS: Flow setup, Regulated power supply

Description:

Quantitative determination of flow rates and mass flow of gases and liquids is important in many fields of engineering, especially process in process control. The types of fluid and its properties are the major factors, which dictate the method of measurement most suitable for the purpose.

In general flow meters can be divided into mechanical and electrical types. in mechanical devices the most common method is to place an obstruction in the flow stream. so as to produce secondary effect such as torque developed on vanes or pressure difference across an orifice plate. The electrical potential developed in a coil by a liquid moving in magnetic field, frequency of rotation of a turbine, change in velocity of sound in moving fluid, and change in resistance of an element placed in the fluid path are some form of the basic principles used in electric type of flow meter.

Rota meter is variable types of flow meter. Consists of vertical tube with a tapered cone in which a float assumes a vertical position corresponding to each flow rate through the tube. The conical tube is made of glass stainless steel or monal and the floats are made of brass, stainless steal, Monel or special plastics
**Procedure:**

1. Close all the valves of the station fill the water to half of the tank of the reservoir.
2. Open the hand valve of the process tank to drain out the water.
3. Now slowly open the hand valve of the air pressure so that the reading gage 1 is 50 Psi.
4. Now with the help of air pressure to 20 Psi.
5. Set the RPS reading to 0 V before connecting it to the signal corresponding equipment.
6. Now switch on the power supply to signal conditioning circuit and to the motor.
7. Turn the motor hand valve to half of one rotation. Slowly increase the supply voltage so that the output of the I/P converter shows 7.5 Psi.
8. Note down the corresponding supply voltage and the flow rate of the water.

9. Keep the motor valve in the same position and in the steps of 0.5 Psi note down corresponding supply voltages.

10. Draw the graph between the flow rate of water and I/P converter O/P

A) MODEL OF EXPERIMENTAL RESULTS:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>RPS READING IN VOLTS</th>
<th>I/P CONVERTER OUTPUT</th>
<th>ROTAMETER READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>7.5</td>
<td>460</td>
</tr>
<tr>
<td>4</td>
<td>2.0</td>
<td>8.5</td>
<td>680</td>
</tr>
<tr>
<td>5</td>
<td>2.5</td>
<td>9.5</td>
<td>880</td>
</tr>
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CALIBRATION:

1. Calibration of V/I converter by using mill ammeter adjusts knob at 0V=4mA and 5V=20mA.

2. Adjustment of pressure gauge NO-3 to 20Psi.

3. Maintain the pressure gauge NO-1 to 30Psi.
MODEL GRAPH:

OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>RPS reading</th>
<th>I/P converter o/p</th>
<th>Rota meter</th>
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RESULT:
VIVA QUESTIONS:

1. List the different types of flow measurement techniques?
2. What are the various types of head type of flow measurement techniques?
3. What are the different types of electrical flow measurement techniques?
4. What are the advantages of electro magnetic flow measurement techniques?
5. Explain the principle of constant current flow measurement techniques?
6. Give the examples for variable area flow measurement techniques?
7. What is the flow measurement technique used in petrol bunks?
8. Explain the working principle of turbine meter flow measurement technique?
9. What are the advantages of venturi tube over than orifice?
10. Explain the working principle of magnetic flow meter?
11. Define volume flow rate?
12. Define Reynolds’s number?
13. What is the significance of Reynolds’s number?
14. Give the mathematical expression for the head type flow measurement technique?
15. How do you measure the blood flow?
16. What is the flow meter used to measure the high viscosity fluids?
17. What is the application of positive displacement flow meter?
18. What is anemometer?
19. Explain the principle of ultrasonic flow meter?
20. Give the mathematical expression for transmission type flow meter?
6. DISPLACEMENT CONTROL

AIM: To measure and control the displacement by LED indication after it reaches the Predetermined set position

APPARATUS:
1. LVDT setup
2. 721 – IC – 3 no
3. Resistors 4.7KΩ - 3 no
4. 10 KΩ - 2 no
5. 1 - KΩ - 4 no
6. 10 KΩ - pot
7. IN 4001 – 2 no
8. LED
9. DMM

DESCRIPTION:
In a linear variable differential transformer the magnetic characteristics of an electric circuit change due to motion of the object. A soft iron core provides the magnetic coupling between the primary coil and the secondary coils connected in series opposition. When the core is central and both secondary are identical the voltage across them are equal in magnitude the net output is zero pas both the secondary are in series opposition. As the core moves up or down the induced voltage of then secondary coil increases while that of the other decreases the output voltage which is modulated is the difference of the two since the secondary are in series opposition. The output proportional to the displacement of the iron core the device is very sensitive and linear over a wide range of motion
PROCEDURE:

1. Rig up the circuit as shown in the figure.
2. Measure the DC output of the precession rectifier for LVDT displacement in steps of 5MM
3. Take the value of max output and minimum output of the precision rectifier and average these values
4. Now set this average value as the reference voltage to cooperator by using signal generator
5. Connect an LED to the potential divider at the output of the operational amplifier
6. Now vary the LVDT core in steps of 0.5MM displacement and observe LED indication
7. The led turns OFF after it reaches the set value
8. Plot the graph between op-amp saturation voltage and displacement
CIRCUIT DIAGRAM:

MODEL GRAPH:

+V_{SAT}  \quad \text{VOLTAGE}  \quad \text{LED ON}

-\text{V}_{SAT}  \quad \text{LED OFF}

\text{DISPLACEMENT}
OBSERVATION TABLE:

<table>
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<tr>
<th>S.NO</th>
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<th>LVDT O/P</th>
<th>RECTIFIER O/P</th>
<th>LED STATUS</th>
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RESULT:

VIVA QUESTIONS:

1. Define residual voltage?
2. How the secondary are connected in LVDT?
3. What are the applications of LVDT?
4. How do you measure the pressure using LVDT?
5. What is theoretical resolution of LVDT?
6. What are the different types of displacement measurement techniques?
7. How do you eliminate the Residual voltage?
8. What are factors have to be taken into consideration to select the core metal?
9. What happened if square wave is connected to the primary side of LVDT?
10. What is RVDT?
11. What are the different types of rotary measurement techniques?
12. What is the order of LVDT?
13. Give the examples for zero order instruments?
14. Liner range of LVDT?
15. Describe the color code of LVDT?
16. Mention the important specifications of LVDT?
17. What is the reference voltage for comparator in your circuit?
18. What is the need of voltage divider network in the circuit?
19. Define the difference between precision rectifier and bridge rectifier?
20. What happens if $V_{CC}$ is changed to 10 V in your circuit?
7. TEMPERATURE CONTROL USING PID

AIM: Regulate the Temperature parameter to the desired level using PID Controller and analyze the behavior of the system.

APPARATUS: Temperature process station, personnel computer

THEORY:

The measurement and control of temperature parameter in any process field has its own importance in order to obtain the optimum response. Using, inventory controller, numeric controller, supervisory controller, programmable logic controller and PID controllers etc control this parameter. PID controller is a stand-alone device and is to be optimally tuned to stabilize the process and to get optimum response of the controller. The soft logic for PID developed in turbo c fulfills the user requirements. The graphical view of the response brings out how the process parameter is responding w.r.t to time. The PID controller has to be tuned using Nichols and Ziegler’s methods. May be either process reaction curve method or an ultimate cycle method.

The final control element (conventional heater of 21xos, 2KW each) is controlled by using dual SCRs. The technique used to fix the SCR is either zero voltage switching or phase angle firing. Zero voltage switching will introduce transient spikes, suppression circuitry must be required. Phase angle firing technique will over come this drawback and delivers the load to the heater based on the error voltage generated by the controller.

Four PRTDs are used to sense the temperature of the liquid at various stages of the process. The motor will suck the water from the tank and drained out (recycle) through the copper tubes of the heat exchanger. RTD-2 and RTD-3 will sense the temperature of the liquid at the inlet and outlet of the chamber. By sprinkling the cold water on to the copper tubes there will be some heat exchange will takes place, hence there may be some significant variation in temperature at RTD-2 and at RTD-3 stages. RTD-0 Sense the inlet temperature of the cold water. RTD-1 Sense out the temperature of the cold water at output drain stage.
The output of each RTD is connected to the corresponding channels in signal conditioning stage. The change of resistance is to be converted in terms of voltage signal. This signal may be driven as input signal to the controller, through the interfacing device (I/O CARD) between the signal conditioner and the controller. The heater controller delivers the load to the Final control element on the O/P of the controller.

**BLOCK DIAGRAM OF TEMPERATURE CONTROL SYSTEM**

**PROCEDURE:**

1. Close the hand valve and remove the feedback path.
2. Connect the RTD-2 terminals to the corresponding terminal points in signal conditioning units.
3. Drive the conditioned signal to the input stage of the I/O Card.
4. Open the main menu program in DOS-MODE enter the suitable values and generates the error signal in terms of voltage.
5. Drive this error voltage as input to the heater controller.
6. Keep the program into ‘RUN’ mode and turn on the heater switch.
7. Once the process maintained study state error, turns the process into “STOP” mode.
8. Switch over the program into tabular view note down the END temperature.
9. Switch over the graphical mode and study the response of the system by analyzing the transient response.

Tuning of the PID controller can do in two methods.
1. Process reaction curve method
2. Ultimate cycle method

**PROCESS REACTION CURVE METHOD:**

Test signal = 0.85

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**PROCESS REACTION CURVE METHOD**

**TRANSIENT RESPONSE:**

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Temperature Controller:

Process reaction curve method

\[ K_p K_i K_D \]

**P only**\( \frac{P}{RL} \)
**P+I**\( 0.9 \frac{P}{RL} \) \( \frac{1}{3.33L} \)
**P+I+D** \( 1.2 \frac{P}{RL} \) \( \frac{1}{2L} \) \( 0.5L \)

\[ K_p K_i K_D \]

**P only** 8.80
**P+I** 7.92 0.0150
**P+I+D** 10.56 0.025 10

Conclusion: The temperature module is operating in over damping with 
\[ \zeta > 1 \]
OBSERVATION TABLE:

<table>
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<tr>
<th>TIME</th>
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<th>TIME</th>
<th>Process value</th>
<th>TIME</th>
<th>Process value</th>
</tr>
</thead>
</table>

RESULT:
SPECIFICATIONS:
Sensor type: RTD – PT 100
   Range : 245°C – 610°C
   Output: 0 – 5V
Temperature coefficient : \(0.00385 \, \Omega/\Omega ^\circ C\)
   : 0.385 / °C
Resolution: ± 0.01 °C
Final control element: 2KW-heater coil 2-Nos
Roto meter range: 0 - 1000LPH
Final controller: Dual SCR
Centrifugal pumps: 0.5 HP, 370 Watts
Speed: 2880Rev/min
Pumps: Pipe size section 25mm(1 inch)
Delivery: 25mm (1 inch)

DIGITAL I/O CARD:
12 Bit ADC facility
Conversion speed: 10 sec
Programmable I/O lines: 48
Unipolar / Bi-polar analog input: - 0 to ±10V, ±15V, ±10V
Compatible to PC-XT/AT
 Acquisition frequency: 25KHz
12Bit DAC facility (2channel)
O/P range: 0-10V

Power requirement: 5V, 1.5A (Max);
   ±12V, 200mA (MAX)

Software: Real time monitoring control (RTMC)
   Version 3.0
   Copy right (C) 1994
   IEI Soft ware, Bangalore.
PRE EXPERIMENTAL QUESTIONS:

1. Define temperature?
2. List different types of temperature transducers?
3. What is a thermister, how is it used for temperature measurement?
4. What are the limitations of thermister?
5. Briefly explain about thermocouples?
6. List and explain about three laws of thermocouples?
7. What are the common materials used for thermocouples?
8. What is a thermopile?
9. How can you measure the temperature in boilers?
10. What are the materials used for manufacturing thermister?

POST-EXPERIMENTAL QUESTIONS:

1. What is the resistance of your thermister at room temperature?
2. How you have placed a thermister on your water tub?
3. How can you set the minimum voltage or temperature in your circuit diagram?
4. Explain how you can adjust the maximum voltage in your circuit diagram?
5. How many iteration it has taken for calibration?
6. Explain in what way you reduced your water temperature?
7. Finally analysis your results?
8. What is meant by Pt-100?
9. Explain law of intermediate temperature?
10. Analyze your results?
9. PRESSURE CONTROL USING PID

AIM: Regulate the pressure parameter to the desired level using PID controller and analyze the behavior of the system.

APPARATUS: Pressure process station, personnel computer

THEORY:

The measurement and control of pressure parameter in any process field has its own importance in order to obtain the optimum response. This parameter is controlled by using inventory controller, numeric controller, supervisory controller, PLC and PID controller’s etc. PID controller is a stand-alone device and is to be optimally tuned to stabilize the process and to get the optimum response of the controller. The soft logic for PID developed in turbo C fulfills the user requirements. The graphical view of the response brings out how the process parameter is responding with respect to time. The PID controller has to be tuned using Nichols and Ziegler’s method, may be either process reaction method curve method or an ultimate cycle method.

The final control element is single seated Butterfly air to open and air to close type. To open and to close the control valve depends on the error signal generated by the controller. Three Gauges on the front panel indicates the input supply from the compressor, regulated output, is the input to the control value, and the out of the I/P converter.

The output of the controller is in terms of volts, range 0-5V. That corresponds to 0-100% valve open. The controller O/P is converted in terms of a current signal and is fed to the I/P converter as input. The output of the I/P converter will drive as an input to the final control element. The pressure filled in the chamber will be sensed by the strain gauge based pressure sensor, and is normalized to PSI form. The conditional signal will be driven as the process value to the controller. With the given set point the controller compares the process value for every 5sec, or 10sec (depends on user criteria) generates an error signal with in the range of 0-5V. The corresponding current signal 4-20mA will be given as input signal to I/P converter. The corresponding output will be 3-15 PSI. That may be given as an input to the Final control element, to drive the valve in the range of 0-100%.
BLOCK DIAGRAM OF PRESSURE CONTROL SYSTEM
PROCEDURE:

1. Remove the feedback signal and drain out the compressed air from the chamber.
2. The input supply (compressed air) is adjusted to about 2 to 2.5 Kg/cm².
3. Using pressure regulator adjusts the input supply to about 20 to 25 PSI.
4. Open the main menu in DOS –MODE enters the suitable values and generate the error signal interns of voltage.
5. Drive this signal as input to the V/I converter.
6. Keep the program into RUN mode and connect the feedback signal as an input signal to I/P converter.
7. Once the process maintains stead state error, turns the process into STOP mode.
8. Switch over the programs into tabular view note down the end temperature.
9. Switch over to the graphical mode and study the response of the system by analyzing the transient response.

PROCESS REACTION CURVE METHOD:

Test signal = 2.10

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**PROCESS REACTION CURVE METHOD**

Process reaction curve Method:

- $K_p K_i K_D$
- P only 7.5
- P+I 6.8 0.0375
- P+I+D 9 0.06254
### TRANSIENT RESPONSE:

<table>
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**TRANSIENT RESPONSE**

![Diagram of transient response](image-url)
CONCLUSION: The pressure variable is under damping system

OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>TIME</th>
<th>Process value</th>
<th>TIME</th>
<th>Process value</th>
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</tbody>
</table>

RESULT:

Specifications:
Input supply: Air compressor self control
RPM : 700
DISP’T: CFM
A.C Induction Motor
H.P : 2
RPM : 1440
415V; 3Ph; 50Hz; 3.6 Amp.
Pressure regulator: with inline filters.

Process chamber:
With stand capacity: 20KG/ cm2
Sensor stage: diaphragm + strain gauge
Final control element: Double seated type.
Material: Cast iron, carbon steal, stain less steel.
Size : 1” to14”
End connection: Flanged type
Packing: V-Teflon
Valve plug: Double seated, equal percentage contoured.

**Actuator:**
Type: spring type pneumatic diaphragm.
Diaphragm material: Neoprene with fabric insert.
Air to Diaphragm: 1.4 to 2.6Kg/Sq.Cm
Valve action: Air to close/ Air to open
I/P Converter:
Model: 760 I/P
Input: 4 – 20 mA
Pressure output: 3 – 15 PSI
Linearity: 0.5%
Sensitivity: 0.1%
Air supply: 1.4 Kg/Sq.Cm + or – 10%
Housing: Aluminium base, with steel cover
Position: Horizontal
Weight: 5Kg approx.

**Digital I/O card specifications:**
12 Bit ADC facility
Conversion speed: 10 sec
Programmable I/O lines: 48
Unipolar / Bipolar analog input: - 0 to ±10V, ±15V, ±10V
Compatible to PC-XT/AT
Acquisition frequency: 25KHz
12Bit DAC facility (2channel)
O/P range:0-10V
VIVA-VOICE QUESTIONS:

1. What do you mean by a process?
2. Can you specify the various types of processes?
3. What do you mean by process variable, manipulated variable.
4. How will you specify the type of the system it will be whether type-0, type-1, or type2.
5. What do you mean by forward path transfer function?
6. How will you make your process system as an automatic control system?
7. What do you mean by a controller?
8. Specify various control systems.
9. What do you mean by computer numerical control?
10. Why should we require PID controller?
11. What is the output of the PID controller?
12. What do you mean by an error?
13. What do you mean by offset?
14. How will you eliminate the offset?
15. Offset cause eliminated by increasing Kp value. Then why should introduce integral.
16. What is the disadvantage of the integral action?
17. What is the other name for integral action?
18. What do you mean by anticipatory action?
19. Out of P, I, D, which one will act as an anticipatory controller.
20. What is the input to the final control element?
9. LEVEL CONTROL USING PID

**AIM:** Regulate the level parameter to the desire level using PID controller
And analyze the behavior of the system

**APPARATUS:** Level process station, Personnel computer

**THEORY:**

The measurement and control of level parameter in any process field has its own importance in order to obtain the optimum response. This parameter is controlled by using inventory controller, numeric controller, supervisory controller, PLC and PID controller’s etc. PID controller is a stand-alone device and is to be optimally tuned to stabilize the process and to get the optimum response of the controller. The soft logic for PID developed in turbo C fulfills the user requirements. The graphical view of the response brings out how the process parameter is responding with respect to time. The PID controller has to be tuned using Nichols and Ziegler’s method, may be either process reaction method curve method or an ultimate cycle method.

The final control element is single seated Butterfly air to open and air to close type. To open and to close the control valve depends on the error signal generated by the controller. Three Gauges on the front panel indicates the input supply from the compressor, regulated output, is the input to the control value, and the out of the I/P converter.

The output of the controller is in terms of volts, range 0-5V. That corresponds to 0-100% valve open. The controller O/P is converted in terms of a current signal and is fed to the I/P converter as input. The output of the I/P converter will drive as an input to the final control element. The pressure filled in the chamber will be sensed by the strain gauge based pressure sensor, and is normalized to PSI form. The conditional signal will be driven as the process value to the controller. With the given set point the controller compares the process value for every 5sec, or 10sec (depends on user criteria) generates an error signal with in the range of 0-5V. The corresponding current signal 4-20mA will be given as input signal to I/P converter. The corresponding output will be 3-15 PSI. That may be given as an input to the Final control element, to drive the valve in the range of 0-100%.
BLOCK DIAGRAM OF LEVEL CONTROL SYSTEM
PROCEDURE: 1

1. Tuning the PID Controller

2. Open the hand valve to about 25% to 30% approx.

3. Drain out the water from the storage tank and read the process value from the signal-conditioning module. If necessary make some zero adjustment.

4. Make the necessary connection that the signal conditioning output as the input to the I/O card and O/P of the controller as input to V/I converter and the O/P of V/I converter as input to the I/P converter.

5. Give some test signal to drive the final control element and then “RUN” the process in open loop until the process value reaches to max span of the reading. Note down the readings for every 10-Sec.

6. Draw the response of the process value against time and then draw a tangent to the graph obtained that will intersect the x – axis then calculate the Gradient ‘R’.

7. Calculate the optimum PID values by substitute the ‘R’, ‘P’, ‘L’ value into the Nicole’s – Ziegler’s table.

8. Enter all the relevant values into the various configuration modes in DOS – Prompt and then RUN the process with the optimally tuned values.

9. Switch over to the graphical mode and analyze the transient response. If there is no steady state error in the response, then try for another method ultimate cycle method instead of process reaction curve method.

10. RUN the process in proportional mode with unity gain and then analyze the response. If the response is satisfactory then RUN the process with Max gain and then analyze the response. If the system is not oscillatory then RUN the process again with some intermediate gain. RUN the process until the system is in oscillatory. Then note down the gain of the system ie; the ultimate gain and note down the period of oscillations is ‘T’ substitute these values in Nichols, Ziegler’s method. Then calculate the optimum PID values.
PROCEDURE: 2

1. Open the hand valve to about 25% to 30% Approx.
2. Drain out the water from the storage tank and read the process values from the signal-conditioning module. If necessary, make zero adjustment.
3. Make the necessary connections that the signal conditioning output as the input to the I/O card and O/P of the controller as input to V/I converter. And the O/P of V/I converter as input to the I/P converter. Then remove the feedback path.
4. Enter into the RTMC directory and open the files with the file name ‘I’.
5. Enter the relevant parameter along with the optimally tuned values of the PID controller generates the error value.
6. Make sure that the error value should be beyond 5V. Keep the process into the STOP MODE and then verify the entire configuration.
7. Then, connect the feedback path and press ‘R’ to RUN the process, switch on the pump at an instant.
8. Wait for some time until the process settle done. Then press ‘Z’ to stop the process. Remove the feed back path, and switch OFF the pump.
9. Then, enter into the tabular view. Note down the END time.
10. Switch on to the graphical mode. Observe the response. Analyze the transient response plotted the process value against time, and bring out the conclusion.
PROCESS REACTION CURVE METHOD:

Power: 230V/50Hz

<table>
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<th>TIME</th>
<th>Process value</th>
</tr>
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PROCESS REACTION CURVE METHOD
TRANSIENT RESPONSE:

Set point = 20 Cm

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Level Control:
Process reaction curve method

\[ K_p K_i K_D \]

P only P/RL
P+I 0.9 P/RL 1/3.33L
P+I+D 1.2 P/RL 1/2L 0.5L

P=2

\[ K_p K_i K_D \]

P only 0.72
P+I 0.652 0.0150
P+I+D 0.864 0.025 10
**OBSERVATION TABLE:**

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<th>TIME</th>
<th>Process value</th>
<th>TIME</th>
<th>Process value</th>
<th>TIME</th>
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**RESULT:**
SPECIFICATIONS:
Input supply: Air compressor self control
RPM : 700
DISP’T: CFM
A.C Induction Motor
H.P : 2
RPM : 1440
415V; 3Ph; 50Hz; 3.6 Amp.
Pressure regulator / Air regulator with inline filter.

Rota meter:
Type : Glass tube
Range : 1000LPH
Float : Inverted cone shaped
No : 2
Storage tank:
Size : 2x2’feet
Material: Stainless steel coated materials.

Sensor type:
Manometer type:
Range : 100Cm/1M
Diaphragm + Strain gauge type:
Final control element: Double seated type.
Material: Cast iron, carbon steal, stain less steel.
Size : 1” to14”
End connection: Flanged type
Packing: V-Teflon
Valve plug : Double seated, equal percentage contoured.
**Actuator:**
Type: spring type pneumatic diaphragm.
Diaphragm material: Neoprene with fabric insert.
Air to Diaphragm: 1.4 to 2.6Kg/Sq.Cm
Valve action: Air to close/ Air to open

**I/P Converter:**
Model: 760 I/P
Input: 4 – 20 mA
Pressure output: 3 – 15 PSI
Linearity: 0.5%
Sensitivity: 0.1%

**Digital I/O card specifications:**
**12 Bit ADC facility**
Conversion speed: 10 sec
Programmable I/O lines: 48
Unipolar / Bipolar analog input: - 0 to ±10V, ±15V, ±10V
Compatible to PC-XT/AT
Acquisition frequency: 25KHz
12Bit DAC facility (2channel)
O/P range: 0-10V

**Software:** Real Time Monitoring Control (RTMC)
Version 3.0

Copy right (C) 1994.
IEI software, Bangalore

**Power:** 230V/50Hz
PRE EXPERIMENTAL QUESTIONS:

1. What is liquid level?
2. Define difference between direct and indirect liquid level measuring devices?
3. How can gamma rays be used to measure liquid level?
4. Explain the principle behind electric liquid level sensors?
5. What are the sensors used to measure liquid levels in metal and non-metallic tanks?
6. How can you measure the liquid level in conductive and non-conductive liquids?
7. What are the different liquid level sensors?
8. How hydrostatic pressure can be used for measuring liquid level?
9. What is the difference between bubbler and purge system?
10. What is the advantages and disadvantages of slight glass method?

POST-EXPERIMENTAL QUESTIONS:

1. Explain about V/I converter?
2. How much pressure you have to maintain as i/p for I/P converter?
3. What is the average time taken for to fill 5cm level at 200LPH-flow rate?
4. How can you control valve opening?
5. What is the technique used for level measurement in your experiment?
6. How can you reduce the error between actual and indicated measurement of level?
7. Explain about the precaution taken for controlling the float rate?
8. What is the range of pressure applying for control value from I/P converter?
9. How level is converted to electrical signal?
10. Finally analyze your results.
11. FLOW CONTROL USING PID

**AIM:** Regulate the flow parameter to the desired level using PID controller
And analyze the behavior of the system.

**APPARATUS:** Flow process station, personal computer

**THEORY:**

The measurement and control of flow parameter in any process field has its own importance in order to obtain the optimum response. This parameter is controlled by using inventory controller, numeric controller, supervisory controller, PLC and PID controller’s etc. PID controller is a stand-alone device and is to be optimally tuned to stabilize the process and to get the optimum response of the controller. The soft logic for PID developed in turbo C fulfills the user requirements. The graphical view of the response brings out how the process parameter is responding with respect to time. The PID controller has to be tuned using Nichols and Ziegler’s method, may be either process reaction method curve method or an ultimate cycle method.

The final control element is single seated Butterfly air to open and air to close type. To open and to close the control valve depends on the error signal generated by the controller. Three Gauges on the front panel indicates the input supply from the compressor, regulated output, is the input to the control value, and the out of the I/P converter.

The output of the controller is in terms of volts, range 0-5V. That corresponds to 0-100% valve open. The controller O/P is converted in terms of a current signal and is fed to the I/P converter as input. The output of the I/P converter will drive as an input to the final control element. The pressure filled in the chamber will be sensed by the strain gauge based pressure sensor, and is normalized to PSI form. The conditional signal will be driven as the process value to the controller. With the given set point the controller compares the process value for every 5sec, or 10sec (depends on user criteria) generates an error signal with in the range of 0-5V. The corresponding current signal 4-20mA will be given as input signal to I/P converter. The corresponding output will be 3-15 PSI. That may be given as an input to the Final control element, to drive the valve in the range of 0-100%.
**BLOCK DIAGRAM OF LEVEL CONTROL SYSTEM**

**PROCEDURE:**

1. Make sure that all the valves are 100% closed.

2. Switch on the 230V main supply.

3. Switch on the motor and adjust the hand valve bypass valve such way that the span of flow rate to 1000LPH.

4. Make the necessary connections that the signal conditioning output as the input to the I/O card and O/P of the controller as input to V/I converter as input to the I/P converter then remove the feedback path.

5. Enter into the RTMC directory and open the files with the file name ‘I’
6. Enter the relevant parameter along with the optimally tuned values of the PID controller generate the error value.

7. Make sure that the error value should be behind 5V. Keep the process into the ‘stop mode’ and then verify the entire Configuration.

8. Then, connect the feedback path and press ‘R’ to RUN the process, switch on the pump at an instant.

9. Wait for some times until the process settle down. Then press ‘Z’ to stop the process. Remove the feed back path, and switch OFF the pump.

10. Then, enter into the tabular view. Note down the end time.

11. Switch on to the graphical mode. observe the response, analyze the transient.

12. Response plotted the process values against time, and bring out the conclusion

Flow parameter should not operate in PID.

The tuned values for flow parameter in PI mode are

\[ K_p = 0.8 \quad K_i = 2 \]

**TABLE:**

<table>
<thead>
<tr>
<th>SETPOINT = 500LPH</th>
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<tbody>
<tr>
<td><strong>TIME</strong></td>
</tr>
<tr>
<td>----------</td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

**RESULTS:**
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DISP’T : CFM
A.C Induction Motor
H.P : 2
RPM : 1440
415V; 3Ph; 50Hz; 3.6 Amp.
Pressure regulator: with inline filters.

Process chamber:
With stand capacity: 20KG/ cm2
Sensor stage: diaphragm + strain gauge
Final control element: Double seated type.
Material: Cast iron, carbon steal, stain less steel.
Size : 1” to14”
End connection: Flanged type
Packing: V-Teflon
Valve plug: Double seated, equal percentage contoured.

Actuator:
Type : spring type pneumatic diaphragm.
Diaphragm material: Neoprene with fabric insert.
Air to Diaphragm: 1.4 to 2.6Kg/Sq.Cm
Valve action: Air to close/ Air to open

I/P Converter:
Model : 760 I/P
Input: 4 – 20 mA
Pressure output: 3 – 15 PSI
Linearity: 0.5%
Sensitivity: 0.1%
Air supply: 1.4 Kg/Sq.Cm + or – 10%
Housing: Aluminium base, with steel cover
Position: Horizontal
Weight: 5Kg approx.

**Digital I/O card specifications:**

12 Bit ADC facility
Conversion speed: 10 sec
Programmable I/O lines: 48
Unipolar / Bipolar analog input: -0 to ±10V, ±15V, ±10V
Compatible to PC-XT/AT
Acquisition frequency: 25KHz
12Bit DAC facility (2channel)
O/P range: 0-10V

**Software:** Real Time Monitoring Control (RTMC)

**VIVA-VOICE QUESTIONS:**

1. What is the input to the final control element?
2. Can you specify the significant difference between actuator and final control element?
3. How will you analyze the behavior of the system?
4. What do you mean by study state error?
5. What do you mean by study state accuracy?
6. What are the factors will influence a study state accuracy.
7. What are the factors will influence on statistic of the process system.
8. Why the float is inverted cone shape.
9. What is the input supply to your process station?
10. What do you mean by pneumatic signal?
11. How much input signal you are taking from the compress.
12. How will you regulate the input supply?
13. What is the required condition to drive the final control element?
14. What is the basic principle of I/P converters?
15. In process configuration why you need to enter process Max-200 in Level, Temp & 20 Kg/Sq.Cm in pressure.
16. What will happen if you enter 100 or 100°C or 10 Kg/Sq.Cm?
17. What is the final control element in temperature process unit?
18. What is the final controller in temperature process unit?
19. Which technique you have used to fix the final controller.
20. What is the Maximum voltage required to fine 100% of your final controller.
11. REALIZATION OF LOGIC EXPRESSION USING PLC

**AIM:** To realize the given expression by constructing the ladder logic diagram

\[ Y = ABC + A'BC + (A + B) C' \]

**APPARATUS:**

1. GEFANUC – PLC
2. PC
3. RS – 232 CABLE
4. CONNECTING WIRES

**PROCEDURE:**

1. Connect the voltage source to the input section and output section of the PLC.
2. Open the VERSAPRO software in PC and create a new folder
3. Double click on the H.W.C icon and replace existed module with NANO -10 Pt/DC/DC/DC module
4. Create ladder logic diagram according to the given expression using NO, NC, COIL contacts
5. Dump the ladder logic diagram into the PLC by clicking ‘connect’ in the PLC window, from the same window click on store to store the run time values
6. Now keep the PLC in the run mode
7. Verify the truth table on the display panel of plc as well as on the monitor of PC.

**RESULT:**
VIVA QUESTIONS:

1. Draw the block diagram of PLC?
2. What are the difference between PLC and computer?
3. What is meant by isolation of PLC?
4. What is the function of watch dog timer?
5. Define RUNG?
6. What are the different programming techniques of PLC?
7. Why PLC called real time controller?
8. Explain about I/O modules?
9. Name the different types of PLC’s?
10. What is the programming language used to program the GEFANUC PLC?
11. Write about I/P modules
12. What is the difference between CPU and Microprocessor in PLC?
13. Define OPTO coupler
14. Draw the ladder logic diagram for AND Gate.
15. Draw the LLD for AB+CA’ expression.
16. What are the advantages of PLC?
17. What are the symbols used in ladder logic diagram?
18. What is the difference between Microprocessor and Micro controller?
19. How PLC is programmed?
20. What is the memory size of your PLC?
12. TEMPERATURE CONTROL USING PLC

**AIM:** To study the temperature control using PLC.

**APPARATUS:**
1. Temperature application trainer (VTAT – 01)
2. GEFANUC PLC (VPLCT – 01)
3. PC
4. RS – 2232 cable
5. Patch cards

**PREFACE:**
The temperature of the water bath is controlled using VERSAMAX NANO PLC. The PLC acts as an error detector and controller (PID). The set point is given to PLC and the PLC compares the set point (SP) and process variable (PV) from the high speed counter and creates an error value and produces the control variable to the controller output set point. Thus the temperature is controlled using.

**PROCEDURE:**

![Diagram of temperature control using PLC]
1. Connect the voltage sources to the input section and output section of the PLC.
2. Make the circuit connections as per the circuit diagram (fig 1)
3. Open the VERSAPRO software in PC and create your own folder.
4. Double click on HWC to configure and replace the default module with the NANO – 10 Pt DC/DC/DC module
5. Enable the channel1 & channel2 counters from the parameter configuration of the replaced module
6. Construct the ladder logic diagram as show in figure 2
7. Dump the LLD in to the PLC by clicking ‘connect’ in the PLC window, from the same window click on ‘store’
8. Enter various PID algorithm parameters
9. Now set the PLC in ‘RUN’ mode
10. Observe the PID temperature control action on the PC monitor

**TYPICAL PID PARAMETERS:**

\[
K_P = 5.00 \% / \% \\
K_D = 0.1 \text{ Sec} \\
K_I = 0.15 \text{ rep/sec} \\
\text{Sample Period} = 0.1 \text{ Sec} \\
\text{Upper Clamp (+ve)} = 32000 \\
\text{SP/PV Range} = 32000 \\
\text{Min Slew Rate} = 1 \text{Sec}
\]

**RESULT:**
VIVA QUESTIONS:

1. What are the different programming devices?
2. What are the similarities between a PC and a PLC?
3. What are the advantages of ladder logic programming when compared with other programming techniques?
4. What are the advantages of PLC?
5. Write the ladder logic diagram of EX-OR function?
6. What is the function of timer in PLC?
7. Define scan rate?
8. What are the important specifications of PLC?
9. What is the heart of the PLC?
10. What are the advantages if we use computer as a programming device?
11. What are different types of ladder logic instructions?
12. What are the advantages of PLC over DCS?
13. What are the disadvantages of PLC over DCS?
14. Expand EEPROM?
15. What are the different types of PID Algorithms available in Versa Pro Soft wear?
16. What are the different types of data transfer operations?
17. What is meant by digital I/P module?
18. What is meant by digital / Analog O/P module?
19. What are the similarities between computer and PLC?
20. Name the different types digital input sources?
21. What is controller relay?
13. TEMPERATURE CONTROL USING DIGITAL PID CONTROLLER

AIM: To control temperature using digital PID controller

APPARATUS:
1. Temperature process station
2. Micro controller (89C51)
3. Connecting wires

PROCEDURE:

1. Make the connection from digital controller to signal conditioning circuit of temperature process station
2. Set the appropriate PID algorithm by pressing the INC/DEC keys on the front panel of digital controller
3. Select the MANUAL or AUTO mode by using INC/DEC keys
4. Enter maximum range using INC, DEC, and BACK keys
5. Type the set point and press enter
6. Type proportional gain (K_p), integral gain (K_i) and derivative gain (K_d) and then press enter key
7. Note down the CV and PV from the section of the PID controller

COLOUR CODE:

RED – BLACK → TO PID CONTROLLER (PROCESSING VARIABLE)

YELLOW – WHITE → FROM PID CONTROLLER TO SIGNAL CONDITIONING MODULE (CONTROL VARIABLE)
OPTIMUM VALUES:
Maximum value = 100
Proportional gain ($K_p$) = 5
Derivative gain ($K_d$) = 0.1
Integral gain ($K_i$) = 0.01

OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>TIME in Sec</th>
<th>% CV</th>
<th>% PV</th>
</tr>
</thead>
</table>

RESULT:

SPECIFICATIONS:

SUPPLY : 220V AC, 50HZ, 12W

INPUT & OUTPUT SIGNAL :
Input current: 4 – 20 mA
Output current: 4 – 20 mA
Resolution: 12 Bit
MEMORY: 64K Flash memory, 256 data memory
VIVA VOICE QUESTIONS:

1. What is the difference between Microprocessor & Micro controller?
2. What are the advantages of PID and compare with the PD configurations?
3. What is the difference between CPU and Microprocessor in Microcomputer?
4. What is the address bus width of 89C51 micro controller?
5. What is the memory size of 89C51 Micro controller RAM?
6. Draw the Block diagram of Temperature process control station.
7. What is the importance of creating disturbance?
8. What is the Data Bus width of 89C51 Micro controller?
9. What is the clock frequency of timers in 89C51 Micro controller?
10. Write the transfer function of PID controller?
11. Draw the circuit diagram of Electronic PID controller.
12. What are the different PID Algorithms available in 89C51 Micro controller?
13. How do you convert the Non Linear Characteristics into Linear Characteristics?
14. What are the different types of materials used to make the thermister?
15. What are the different types of RTD’s?
16. What are the various types of tuning methods in process control?
17. What is the significance of process reaction curve method?
18. List the different types of non-electrical temperature measurement techniques?
19. What is meant by thermo bole?
20. Name the transducers used to measure the temperature flux?