1907505 INDUSTRIAL INSTRUMENTATION LABORATORY MANUAL

(For Fifth semester B.E – E.I.E Academic Year 2022-2023)

REGULATION-2019

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR – 603 203

Prepared by

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GENERAL RULES FOR PERSONAL SAFETY

1. Always wear tight shirt/lab coat, pants and shoes inside workshops.
2. Remove all Metal Jewels since rings, wrist watches or bands, necklaces, etc. make excellent electrodes in the event of accidental contact with electric power sources.
3. Do not make circuit changes without turning off the power.
4. Make sure that equipment working on electrical power are grounded properly.
5. Avoid standing on metal surfaces or wet concrete.
6. Keep your shoes dry.
7. Never handle electrical equipment with wet skin.
8. Hot soldering irons should be rested in its holder. Never leave a hot iron unattended.
9. Avoid use of loose clothing and hair near machines and avoid running around inside lab.

SYLLABUS

LIST OF EXPERIMENTS

1. Measurement of speed, torque and vibration.

2. Calibration of ammeter, voltmeter and wattmeter using multifunction calibrator

3. Calibration of pressure gauge using dead weight tester.

4. Measurement of level using d/p transmitter and fibre optics system.

5. Measurement of flow using

    a. Discharge coefficient of orifice plate

    b. Calibration of Rotameter

6. Design and Testing of Electromagnetic Flow meters.

7. Measurement of temperature using IR thermometer and IC sensor

8. Measurement of Absorbance and Transmittance of Test solutions using UV-Spectrometer.

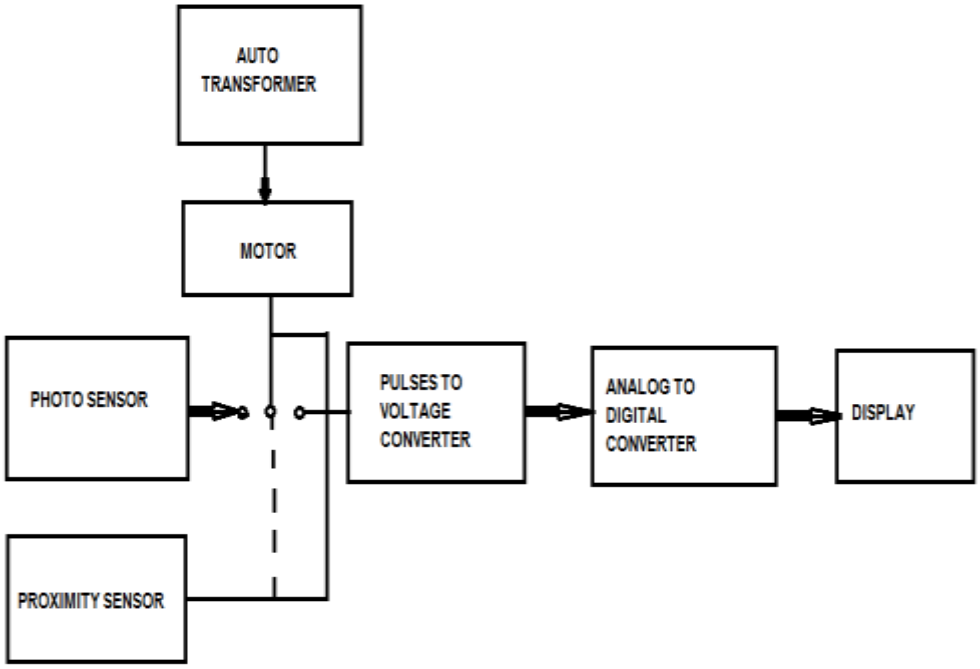
9. Measurement of Conductivity, Moisture and Viscosity of test solutions

10.Standardization and measurement of pH values of different solutions

11.Measurement and analysis of ECG and pulse rate.

CONTENTS

BLOCK DIAGRAM FOR PHOTOELECTRIC TACHOMETER

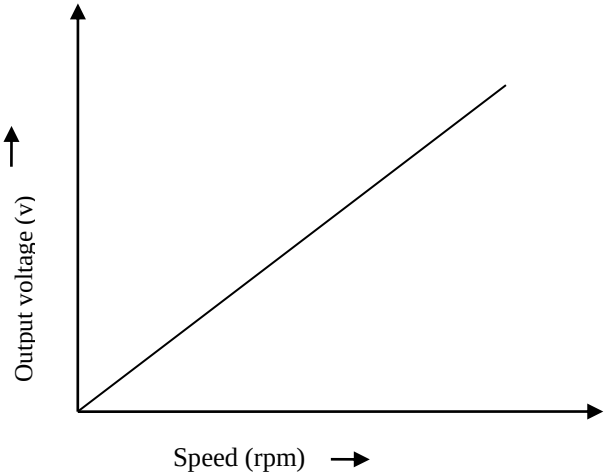


Tabulation

S.No	Voltage (V)	Speed (rpm)

Model Graph:

Speed Vs Output Voltage



1. AMEASUREMENT OF SPEEDBY PHOTOELECTRIC TACHOMETER

Aim

To obtain the characteristics of Photoelectric Tachometer.

Apparatus required

i. Photo electric tachometer
ii. Multimeter
iii. DC motor unit.

i) Magnetic Pickup :

The voltage is induced in the coil around to a magnetic subjected to change in magnetic field, this is principle of electromagnetic induction. As shaft rotates, the teeth pass in front of pickup and produce a change in field resistance of magnetic circuit. The density of a magnetic field increases and decreases as each tooth approaches and leaves away from the end of the bar magnet per second. Let T be no. of teeth on the rotor, N be be the revolutions per second and P be the no. of pulse per sec. Then,

$$\text{Speed } N = \frac{\text{Pulses per sec. } P}{\text{No. of teeth } T} = \frac{}{} \times 60 \text{ rpm}$$

ii) Photoelectric pickup :

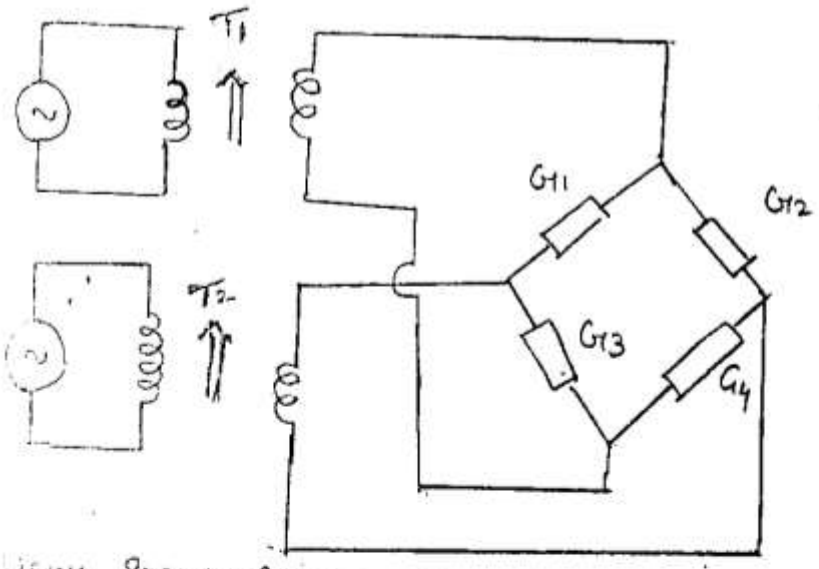
The photoelectric pick up tachometer utilize a rotating shaft to the intercept a beam of light flow on a photoelectric or photo-conductive cell. The shaft has an intermittent reflecting (white) and non reflecting (blade) surface. When a beam of light the reflecting surface on a rotating shaft, light pulses are obtained and reflected light is focused on the photoelectric cell. The frequency of the light pulses is proportional to shaft speed and so will be frequency of electrical o/p pulses from photoelectric.

Procedure

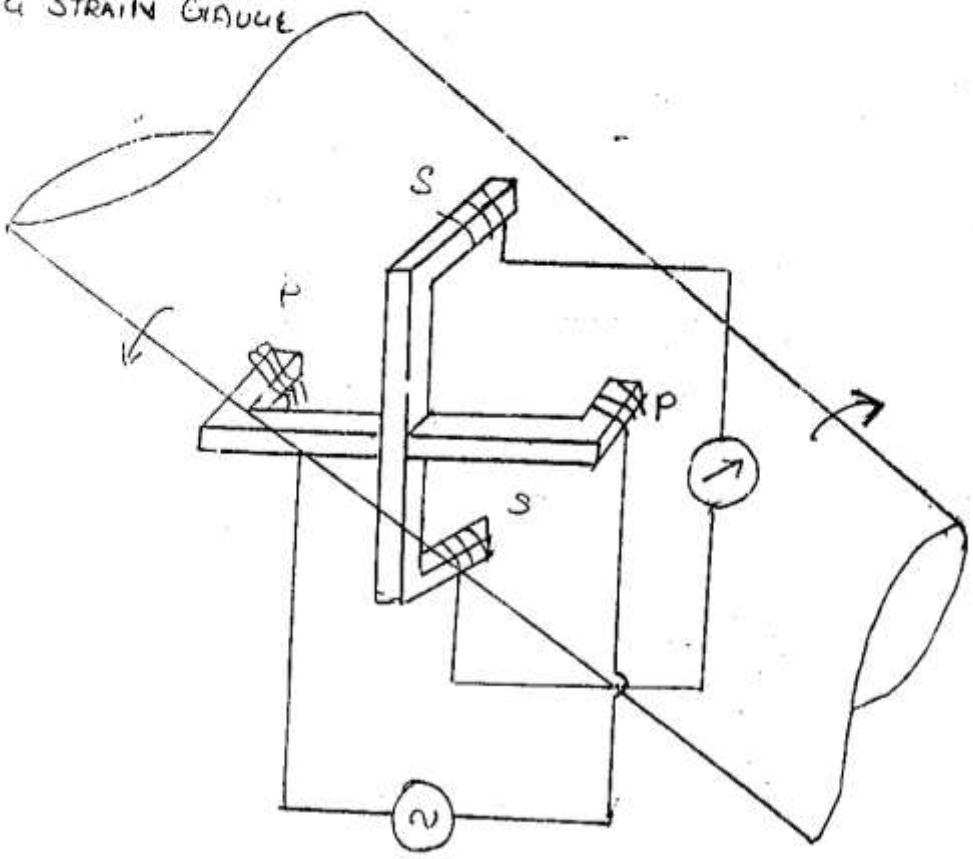
1. Ensure the power is off to the servomotor controller unit and pulse ON / OFF switch is in OFF position.
2. Ensure the speed feedback loop is open, so that the motor is operated on open loop.
3. Connect the motor to the output of the power amplifier in the servo controller through (0-2) A ammeter, connect a voltmeter (0-30) V across the motor armature.
4. Set the controller to be proportional by connecting the I controller input to ground.
5. Set the proportional gain K_p at minimum (unity).
6. Switch on power to the motor controllers.
7. Set V_{ref} = 1 Volt slowly increase the gain K_p voltage by means of the proportional gain adjustment pot, and find the voltage at which the motor just starts running.
8. Vary the reference voltage in steps and for each step, note down the motor speed and armature voltage. Tabulate the readings.
9. Plot the graph between Speed V_s Output voltages

Result: Thus the characteristic of photoelectric tachometer was obtained

CIRCUIT DIAGRAM FOR STRAIN GAUGE SET UP



USING STRAIN GAUGE



1. BMEASUREMENT OF TORQUE

AIM:

To determine the torque due to dead weights using strain torsion meter and to determine the unknown weight.

APPARATUS REQUIRED:

i) Strain gauge torsion meter.
ii) Dead weight.

THEORY:

Torque is generally referred to as an angular twist (i.e.) the force that is being applied at a particular angle. Torque can be obtained by measuring force at a known distance.

Torque is given by $T = Fr$ Nm

Where, F = Force in Newton,

r = Distance at which the force is measured in meter.

The torque measuring device used here makes use of four strain gauges that are arranged in a Wheatstone bridge model. When an angular force or a torque is applied two of the strain gauges undergo a compressive force while two other strain gauge undergo tensile force. This result in the change as far as the dimensions of the strain gauge element is concern which in turn changes the resistance. This change in resistance ensures a production of an output voltage which is a measure of the applied torque.

PROCEDURE:

1 Connect the strain gauge torsion meter to the power supply.
2 Check for calibration of initial zero torque.
3 Now change or fix the hanger so that the shaft is subjected to torque.
4 Now keep the deadweights in the hanger gently.
5 Note the indicated torque value from the strain gauge torsion indicator.
6 Repeat the same for different weights and tabulate the readings.
7 Now repeat the same procedure for the given unknown weight.
8 The unknown weight is interpreted from the graph.
9 The graph is plotted between deadweights and indicated torque value.

TABULATION:

Table: 1 Constant Length=_____m.

S.No	Dead Weights (gms)	Indicated torque (kgM)

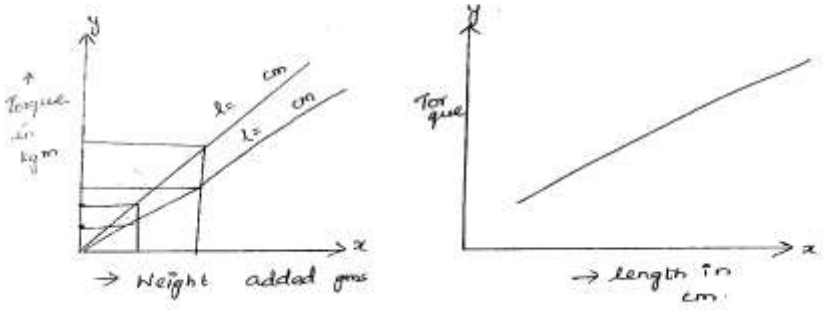
Table: 2 from Graph

Length (cm)	Unknown Weight (gm)	Torque indicated (KgM)	Interpreted Weight (gm)

Table: 3 Constant Weight (Weight = gms)

Length (cm)	Torque (KgM)

MODEL GRAPH



RESULT:

Thus the torque due to deadweights was determined using Strain torsion meter the value of unknown weight was determined.

CIRCUIT DIAGRAM

2. A **CALIBRATION OF AMMETER**

AIM

To calibrate the ammeter by using DC cromptons potentiometer.

APPARATUS REQUIRED

1. DC cromptons potentiometer.
2. Current shunt.
3. DC power supply.
4. DC portable ammeter(0-3A).

EXPERIMENTAL PROCEDURE

1. Standardize the DC potentiometer using standardization procedure.
2. Connections are made as per the connection procedure.
3. Switch on the DC power supply and vary the voltage, such that current flows through the ammeter.
4. Set a particular current value, according to the current flow the voltage drop across the resistor acts as input to the potentiometer.
5. Now adjust the two voltage dials for getting null deflection in the galvanometer.
6. The voltage at which zero or null deflection occurs the voltage across the shunt resistor.
7. The current can be calculated by using the formula , I=V/Rs

Where I = current through potentiometer

V = Potentiometer Reading

Rs = Shunt Resistance

7. Repeat the same procedure with another value of Rs.
8. Compare the current measured through potentiometer and ammeter.
9. The resulting value given the error to the ammeter.

Note:

Shunt resistance (**Rs**) value across

1. R1 & R2 consists of **0.303** resistance.
2. R3 & R4 consists of **0.577** resistance.

RESULT Thus the Ammeter is calibrated and the error is found to be _ _ _ _ _ _ _

Calibration of ammeter :

Ammeter reading I_M	True current measured by Pot, I_T	% Error = $(I_M-I_T) / I_T \times 100$

Calibration of Voltmeter :

Voltmeter reading V_M	True voltage measured by Pot, V_T	% Error = $(V_M-V_T) / V_T \times 100$

2. B **CALIBRATION OF VOLTMETER**

AIM

To calibrate the voltmeter by using DC cromptons potentiometer.

APPARATUS REQUIRED

1. DC cromptons potentiometer.
2. Portable meter(0-50V)DC.
3. Volt ratio box.
4. DC power supply.

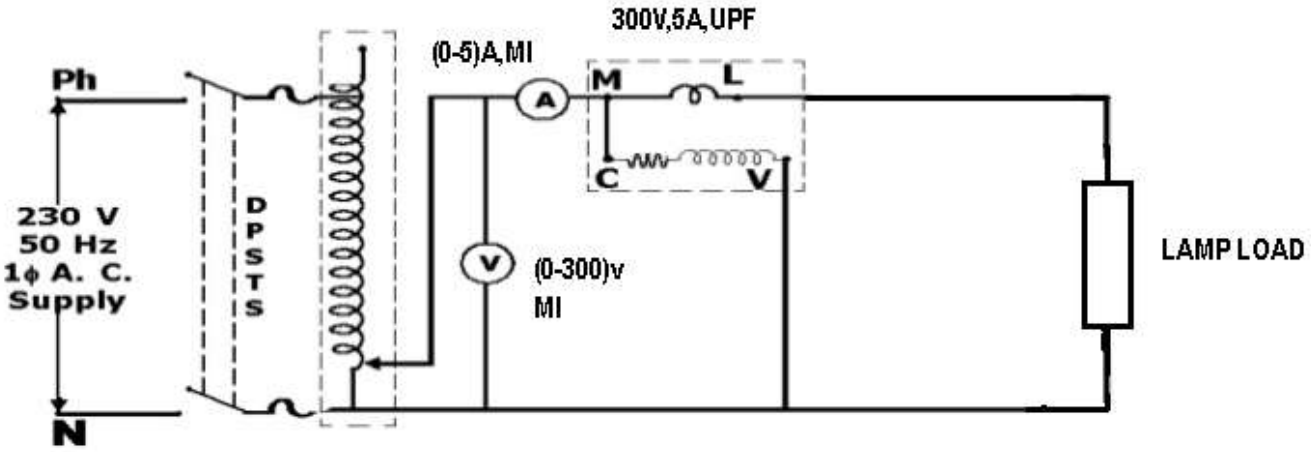
EXPERIMENTAL PROCEDURE

1. Standardize the DC potentiometer using standardation procedure:
2. Connections are made as per the connection procedure.
3. Switch on the DC power supply and set the voltage at 50V.
4. The voltage across the R2 resistor flows as input voltage to potentiometer.
5. Adjust the two dials VOLTS& MILLIVOLTS for getting null deflection in galvanometer.
6. Note down the reading of the potentiometer.
7. Calculate the voltmeter reading by using the formula.
8. Compare the voltage measured through the voltmeter and potentiometer.
9. The resulting value gives the error of the voltmeter.

RESULT

Thus the Voltmeter is calibrated and the error is found to be _ _ _ _ _ _ _.

CALIBRATION OF WATTMETER



TABULATION

S. No.	Voltage (V)	Current (A)	Practical Value (P)	Theoretical Value (T)	% Error = (P-T/T) * 100

2. C.**CALIBRATION OF WATTMETER**

Aim

The aim of the experiment is to calibrate the given wattmeter by direct loading**.**

Components Required

1. Voltmeter (0 - 300) V MI.
2. Ammeter (0 - 5) A MI.
3. Wattmeter (1500W, 5 / 10A).
4. Lamp Load.
5. Connecting wires

Formula

True Value = Voltmeter reading * Ammeter Reading * Power factor

Actual reading = Wattmeter reading

% Error = [(True Value - Actual Reading) / True value] * 100**.**

Theory

The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Electromagnetic wattmeters are used for measurement of utility frequency and audio frequency power; other types are required for radio frequency measurements.

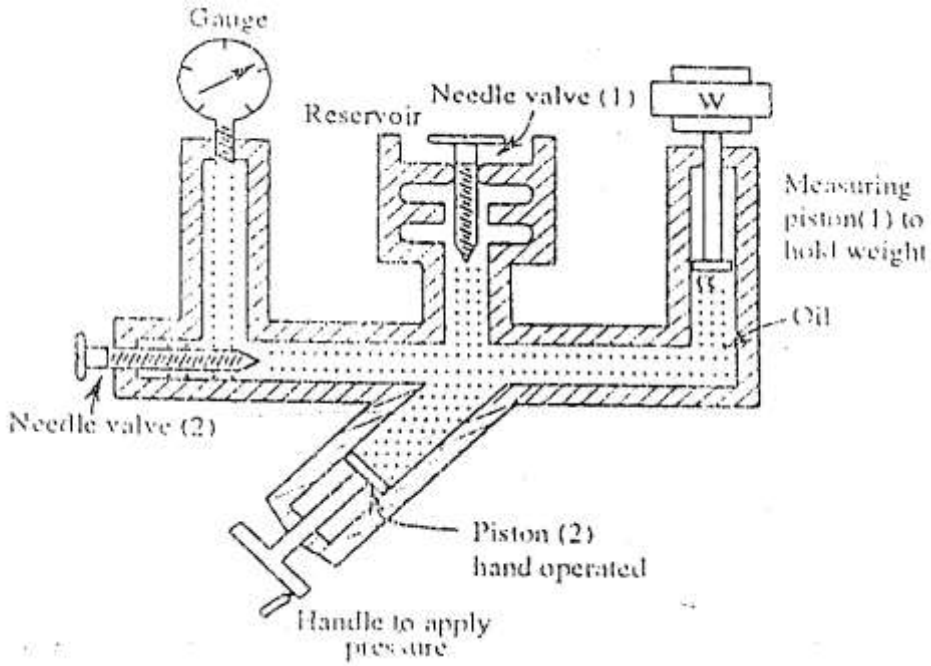
The traditional wattmeter was an electrodynamometer instrument with a rotating potential coil of many turns and a fixed current coil of a small number of turns. The torque on the moving coil was proportional to the product of current and voltage, and therefore to the instantaneous power. The inertia of the moving coil and pointer averaged the torque. Multipliers and shunts could be used as with ordinary voltmeters and ammeters. The scale had to be calibrated, since the torque depended on the coil position.

Procedure

1. The connections are given as per the circuit diagram.
2. The Auto transformer is initially kept at minimum position and main supply is switched on.
3. Now the auto transformer is varied slowly up to the supply voltage value.
4. Vary the load in steps and note down the corresponding voltmeter, ammeter and wattmeter reading and tabulated.
5. The Graph (Error Vs Load Current) is plotted

Result

Thus the given wattmeter is calibrated.

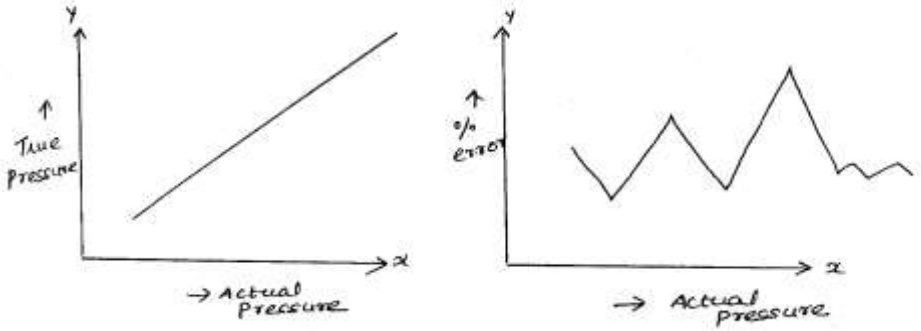


BLOCK DIAGRAM OF DEAD WEIGHT TESTER

TABULATION:

S.No	Actual Pressure p_1 (kg/cm^2)		Measured Pressure P_2(kg/cm^2)		% Error
	Ascending	Descending	Ascending	Descending	

MODEL GRAPH



3. CALIBRATION OF PRESSURE GAUGE USING DEAD WEIGHT TESTER

AIM:

To calibrate the given pressure gauge using the dead weight tester and plot the graphs for

(i) Actual pressure Vs True Pressure

(ii) Actual pressure Vs True Error

APPARATUS REQUIRED:

i) Dead weight Tester

ii) Pressure gauge

iii) Standard Weight

THEORY:

The laboratory standard of pressure is the dead weight tester and is very often used to calibrate Bourden gauges and other pressure sensing device. It is an absolute measuring device although it can be adopted as a comparison calibration method as well. It uses the well known Pascal's law for its operation which states that"pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid such that the pressure ratio (initial difference) remains the same which is given by,

$$= \rho g ($$

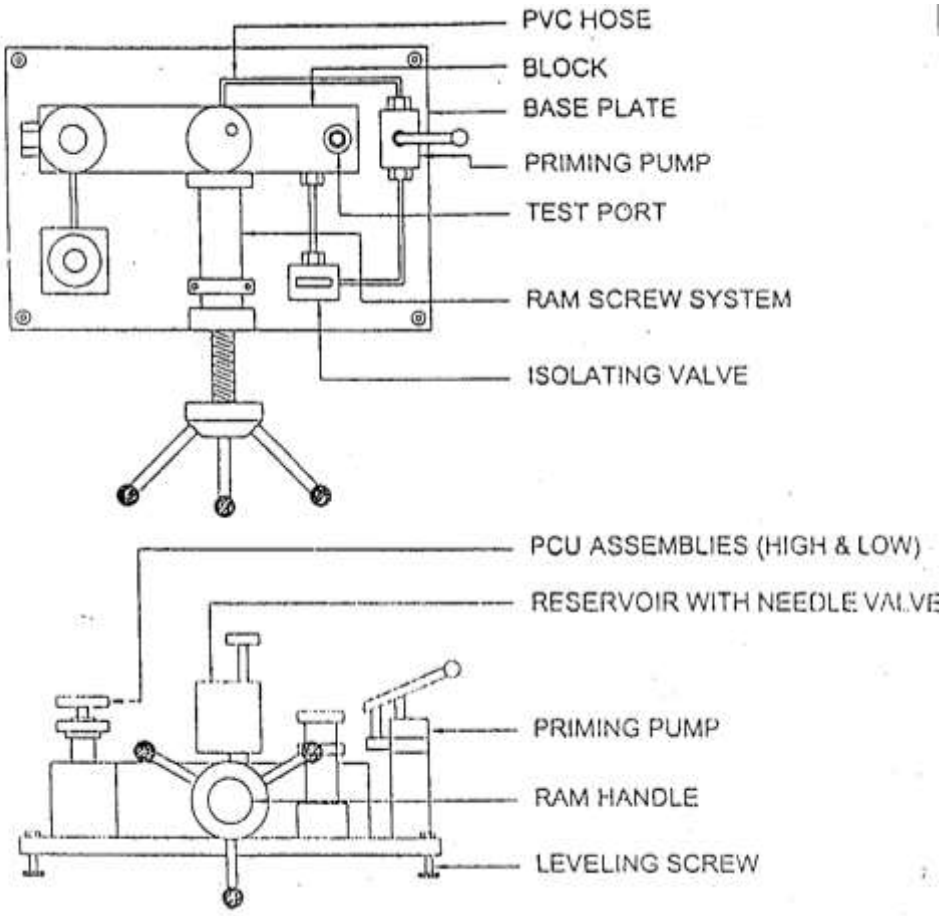
Where,

Hydrostatic pressure or the difference in pressure at two points within a fluid column, due to the weights of the fluid.

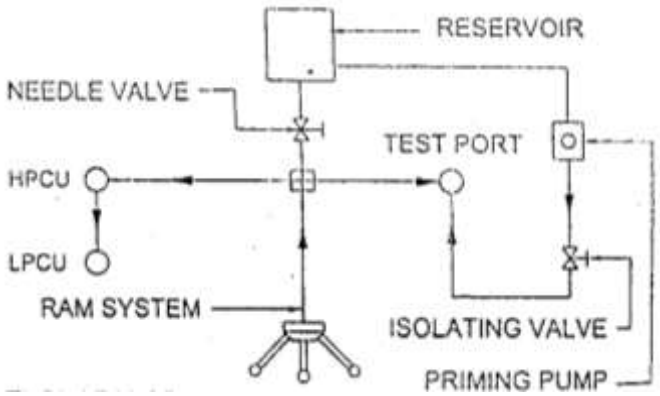
ρ = Density of the fluid.

G = Acceleration due to gravity.

= The height of fluid above the point of measurement, or the difference in elevation between the two points within the fluid column



FRONT & TOP VIEW OF DEAD WEIGHT TESTER EXPERIMENTAL SET UP



FLOW DIAGRAM OF DEAD WEIGHT TESTER

FORMULA

i) % Error = $\frac{P_1 - P_2}{P_1} \times 100$

Where,

p_1= Actual Pressure

P_2 = Measured Pressure

PROCEDURE:

1. Fill the oil in reservoir approximately ¾ th of total reservoir and make sure that the inlet and outlet valves are closed.
2. Now open the inlet valve and withdraw the handle until the piston is filled with the oil.
3. Close the inlet valve and place the pressure gauge of the instrument which is to be calibrated.
4. Place standard weight of 0.5kg/cm^2 of the weight carrying assembly equal to the estimated pressure.
5. Apply pressure through handle in clock wise direction gently until the weight carrying assembly is at a raised position.
6. Ensure the piston is at final position and note down the weight added and take the readings.
7. Repeat the above procedure from step 4 for different weight and calculate the True pressure and % of error.
8. After taking all the reading open the valve and rotate the handle in clock wise direction so that oil is accumulated in the reservoir.
9. The graphs between

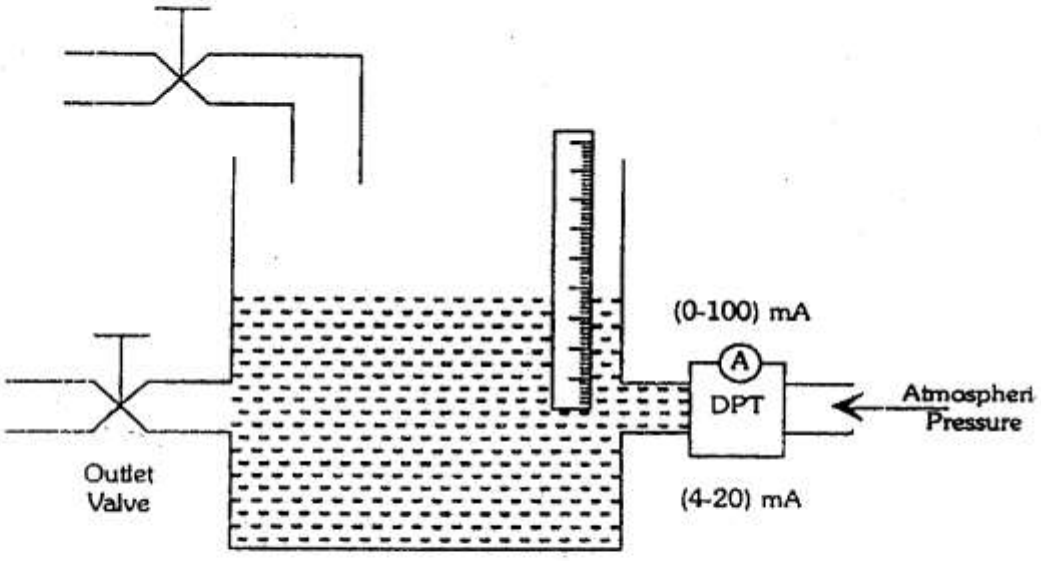
   Actual pressure Vs True Pressure

   Actual pressure Vs True Error has been plotted.

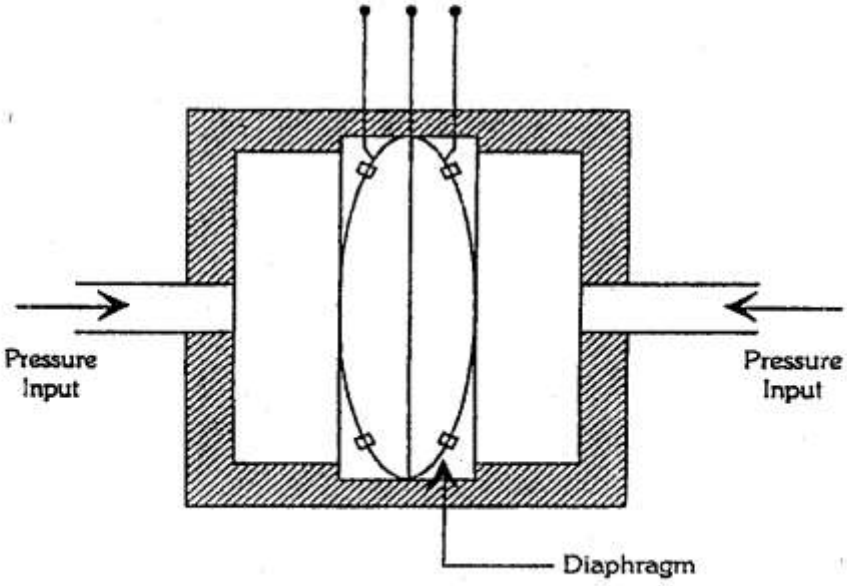
RESULT:

Thus the given Pressure Gauge was calibrated using the dead weight tester and the required graphs are plotted

EXPERIMENTAL SETUP



DIFFERENTIAL PRESSURE TRANSMITTER :



4.MEASUREMENT OF LEVEL USING D/P TRANSMITTER

AIM:

To measure the level of liquid in the tank with the differential pressure transmitter and Fibre Optic waves in terms of mA.

APPARATUS REQUIRED:

i) DPT
ii) Container

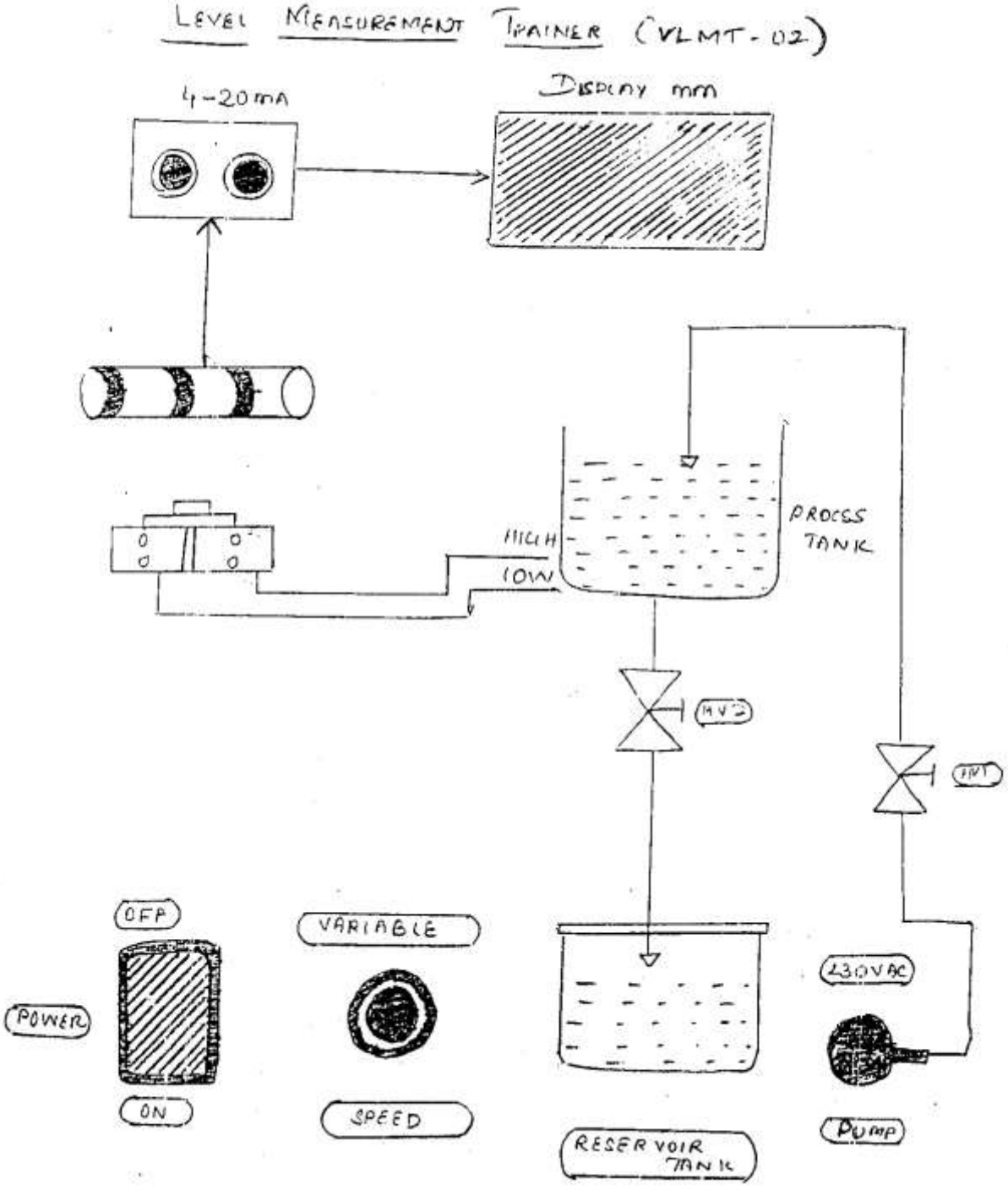
THEORY:

The differential pressure detector method of liquid level measurement uses a differential pressure detector connected to the bottom the tank being monitored. The high pressure, caused by the fluid in the tank, is compared to a lower reference pressure (usually atmosphere).The tank is open to the atmosphere; therefore, it is necessary to use only the high pressure connector on the differential pressure transmitter.
With the lower pressure side being open to the atmosphere the differential pressure is the hydrostatic head of the liquid in the tank Most of the tanks are totally enclosed to prevent vapor or steam from escaping, or to allow pressurizing the contents of the tank. In this case both the high pressure and the low pressure sides of the differential pressure transmitter must be connected.

Fibre Optic waves are generated by the source which are used for the purpose o0f measurement of height of the liquid tank.

PROCEDURE:

1 Weight the empty container and calibrate the zero level to 4mA.
2 Fill the container with the water and calibrate the full level to 20mA.
3 Now perform the experiment in ascending order insteps of 5cms.
4 Repeat the same procedure for the descending order and tabulate the reading.
5 A graph is plotted between the liquid level and its corresponding current output.



EXPERIMENTAL SETUP OF DIFFERNTIAL PRESSURE TRANSMITTER

TABULATION:

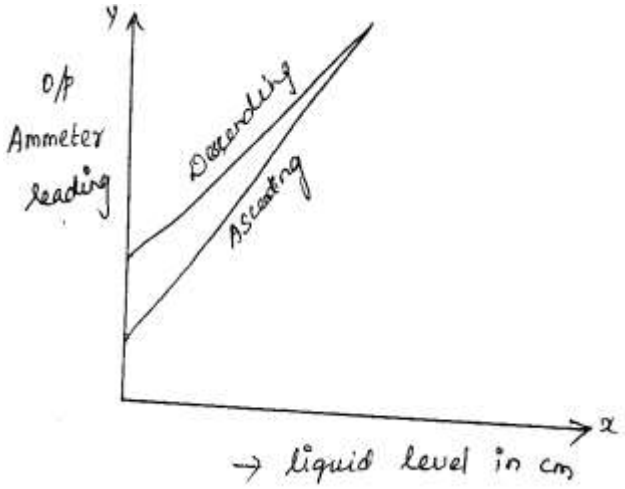
Table: 1 Ascending Liquid Level

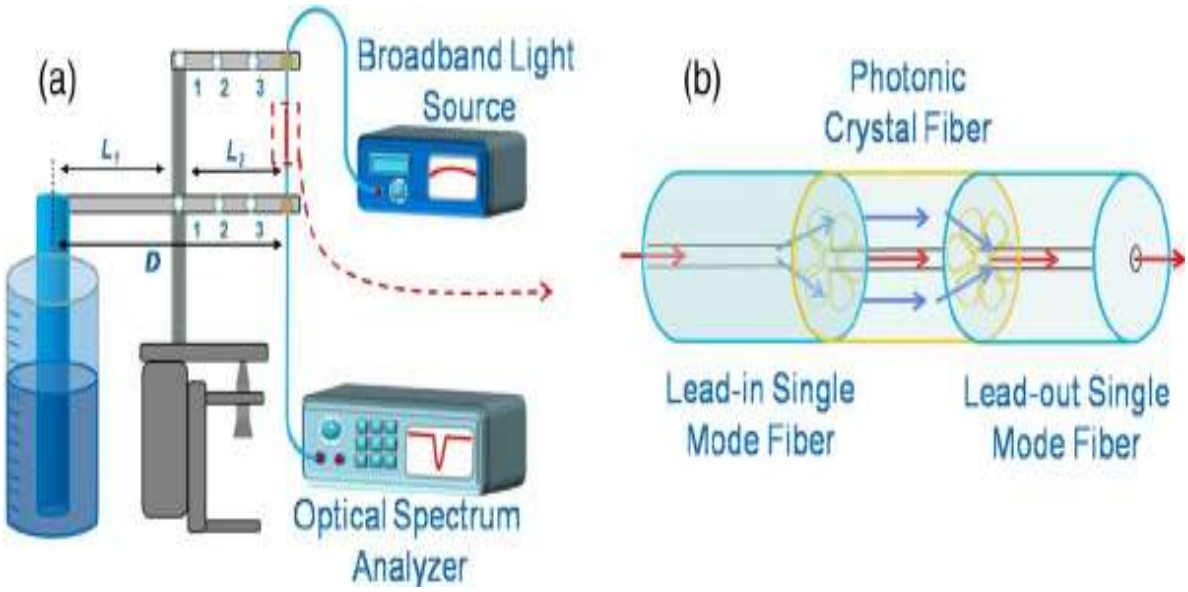
S.No	Liquid Level(cm)	Output Current(mA)

Table: 2Descending Liquid Level

S.No	Liquid Level(cm)	Output Current(mA)

MODEL GRAPH





EXPERIMENTAL SETUP OF FIBRE OPTIC SENSOR FOR LEVEL MEASUREMENT

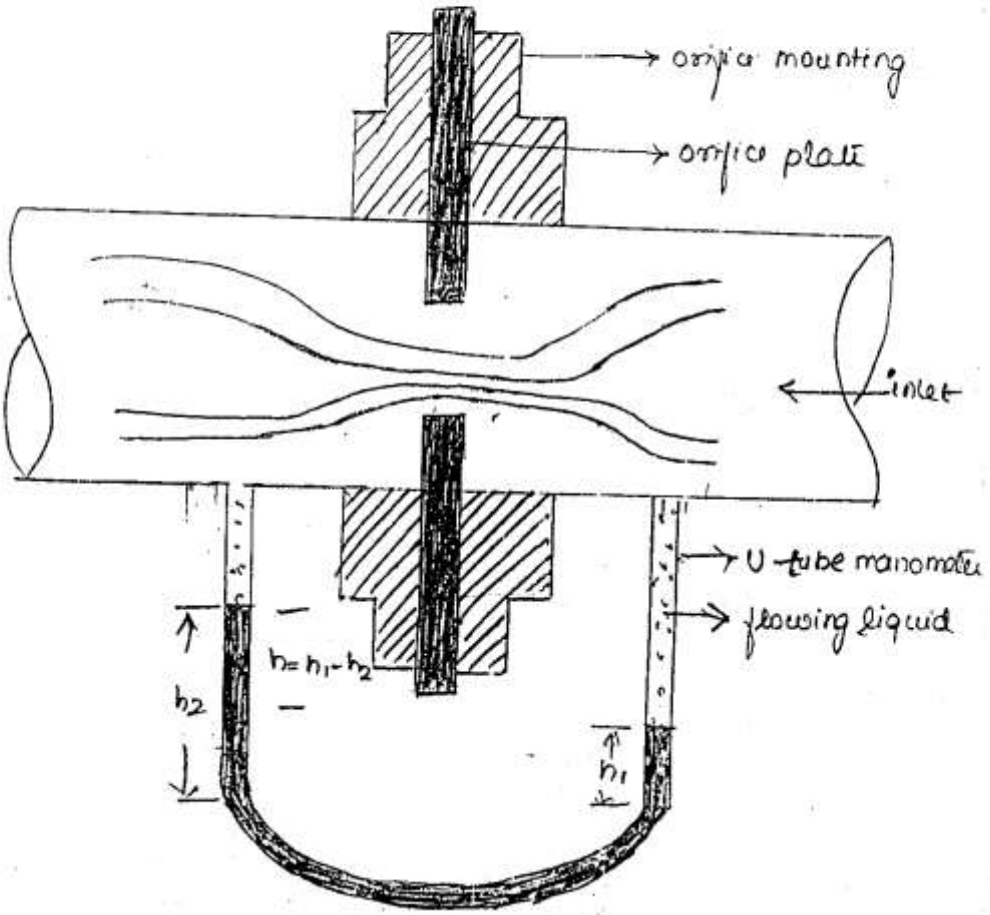
TABULAR COLUMN

S.No	Liquid Level(cm)	Sensor Output (mA)

RESULT:

Thus the liquid in the tank was measured with differential pressure transmitter and fibre optic sensor and the graph was plotted.

ORIFICE METER MEASUREMENT SETUP.



5. ADISCHARGE CO-EFFICIENT OF ORIFICE PLATE

AIM:

To determine the discharge co-efficient of given orifice plate.

APPARATUS REQUIRED:

Orifice meter, manometer, stop watch, collecting tank, sump tank and supply pump.

PRINCIPLE:

Orifice meter is a variable head type of flow measuring device and it operates on the principle that a restriction (obstruction) in the line (pipe) of a flowing fluid introduced by the orifice plate produces a differential pressure across the restriction element which is proportional to the flow rate.

This relation between differential pressure and flow rate is derived from the Bernoulli's principle which states that in a flowing stream, the sum of the pressure head, the velocity head and the elevation head at one point is equal to their sum at another point removed in the direction of flow from the first point plus the loss due to the friction between these two points.

CO-EFFICIENT OF DISCHARGE:

In a nozzle or other constriction, the discharge coefficient (also known as coefficient of discharge) is the ratio of the mass flow rate at the discharge end of the nozzle to that of an ideal nozzle which expands an identical working fluid from the same initial conditions to the same exit pressures

THEORY:

Orifice meter is a device used to measure the rate of discharge of any liquid flowing through the pipe line. The pressure difference between the pipe section and the throat of the orifice meter can be measured from the differential manometer.

$C_d = Q_{act}/Q_{th}$

$Q_{th} = \sqrt{2gH}\,\frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}}\ m^3/sec$

$Q_{act} = ah/t\ m^3/sec$

$H = (h_1 - h_2) \times \frac{(\rho_m - \rho_l)}{\rho_l}\ m$

TABULATION:

S.No	Time taken for 5 cm rise (s)	Manometer Reading			Actual discharge Q_{act} (m^3/sec)	Theoretical discharge Q_{th} (m^3/sec)	Co-efficient of Discharge C_d
		h_1 (m)	h_2 (m)	H=$(h_1 - h_2)$ (m)			

MODEL CALCULATION:

Area of the pipeA_1= 9.6 ×10^{-2} m^2
Area of the pipeA_2 = 2.4 ×10^{-2} m^2
Area of the tank= 0.06 m^2
Height at which the water Level increases to collect 5 cm of water= _____m
Theoretical discharge

$$Q_{th} = \sqrt{2gH}\,\frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}}\ m^3/sec$$

Q_{th}= _____m^3/sec

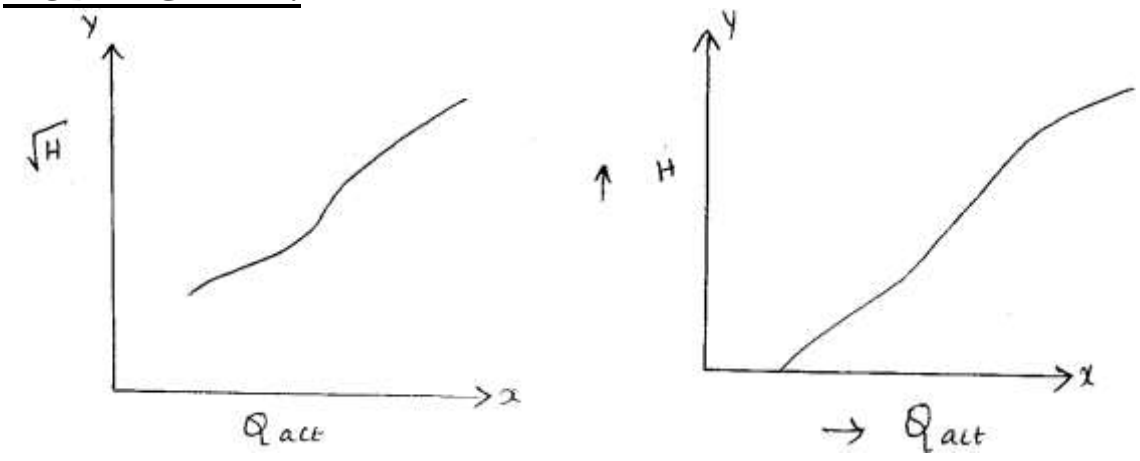
Actual discharge

Q_{act} = ah/t m^3/sec
Q_{act} = _____ m^3/sec

Coefficient of discharge

C_d= Q_{act}/Q_{th}
C_d= _____

MODEL GRAPH:



Where,

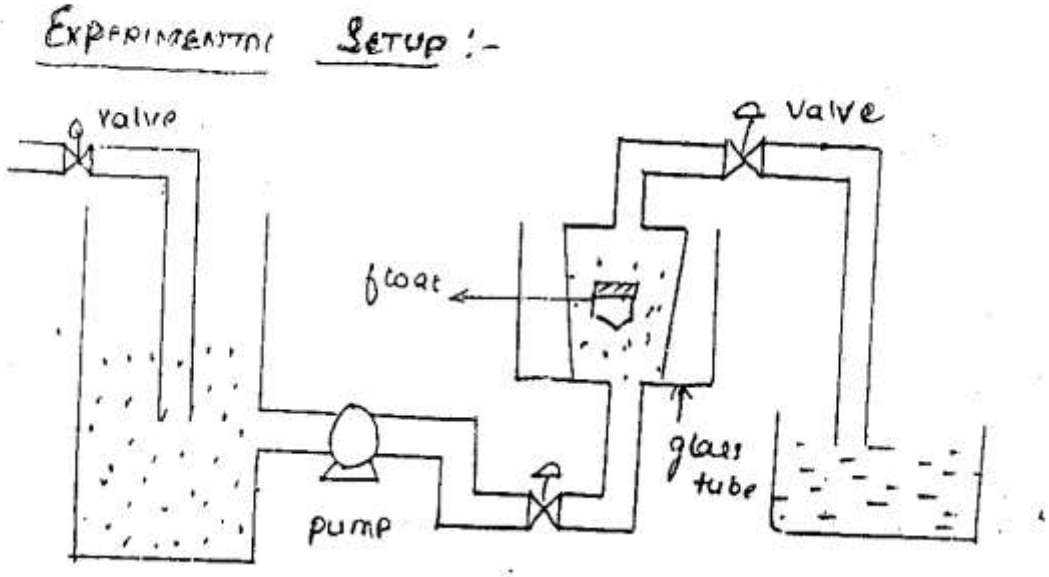
C_d = Discharge coefficient
Q_{th} = Theoretical discharge m^3/sec
Q_{act} = Actual discharge m^3/sec
g =Gravity m/s^2
A_1 =Area of pipe m^2
A_2 =Area of orifice m^2
H =Differential head of flowing liquid m
h_1 , h_2 =Manometric heads m
ρ_m =Density of manometric liquid
ρ_l =Density of flowing liquid
a =Area of the collecting tank m^2
h =Rise in water level m
t =Time take for 'h' rise sec

PROCEDURE:

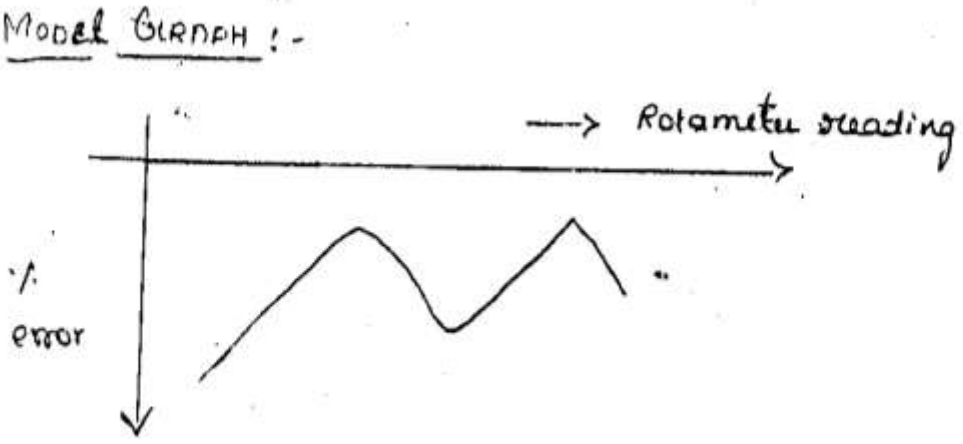
1 Check whether all the joints are leak proof and water tight.
2 Close all the cocks in the pressure feed pipes and manometer to prevent damage and overloading of the manometer.
3 Check the gauge glass and meter scale assembly of the measuring tank and see that it is water tight and fixed vertically.
4 Prime the manometer properly.
5 Open the inlet valve.
6 Switch on the pump and adjust the control valve to allow the water to flow through the orifice meter steadily.
7 Open the upstream and the downstream cocks of the manometer to connect the pipe for which the friction factor has been found.
8 Note down the manometer head.
9 Measure the time taken for the h 'm' rise in the collecting tank to find the actual discharge and hence the velocity.
10 Calculate the friction factor.
11 Repeat the procedure for different flow rates.
12 The graphs for $\mathbf{Q_{act}}$ **Vs H** and $\mathbf{Q_{act}}$ **Vs** $\sqrt{\mathbf{H}}$were to be plotted

RESULT:

The co efficient of discharge for the Orifice meter is found out and the necessary graphs are plotted. The value of C_d =



EXPERIMENTAL SET UP ROTAMETER FOR FLOW MEASUREMENT



5. B CALIBRATION OF ROTAMETER

AIM:

To calibrate the Rotameter by measuring standard or known flow of fluid in the pipe.

APPARATUS REQUIRED:

Rotameter with Fluid flow measurement setup, Meter scale and Stop watch.

THEORY:

The Rota meter is basically a variable area flowmeter.In the differential head flow meter (Orifice meter, Venturi meter etc) the retraction is of fixed size and the pressure differential across it changes with the flow rate; whereas in the case of rotameter the size of the restriction is adjusted by an amount necessary to keep the pressure differential constant when the flow rate changes and the amount of adjustment required is proportional to the flow rate.

The Rota meter consists of a vertically tapered tube with a float which is free to move up or down within the tube. The free area between the float and the inside wall of the tube form an annular orifice. When there is no flow through the rotameter the float rests at the bottom of the metering tube where approximately the maximum diameter of the float is approximately the same as the bore of the tube. When the fluid enters the metering tube the float moves up and the flow area of the annular orifice increases. Thus the float is pushed upwards until the lifting force produced by the pressure differential across its upper and lower surface is equal to the weight of the float. At this juncture a calibrated scale printed on the tube or near it, provides a direct indication of the flow rate. Thus the distance through which the float has moved in order to attain a constant pressure difference across it, has become the measure of flow rate, for a fluid of given density and viscosity.

FORMULA:

$$\text{Actual Reading } I_a = \frac{A.h}{t}$$

$$\%\ \text{error} = \frac{\text{Actual Reading - Measured Reading}}{\text{Measured Reading}} \times 100 = \frac{I_a - I_m}{I_m} \times 100$$

TABULATION:

S.no	Rota meter reading (lt/hr) I_m	Time taken(sec) T	Actual reading Ia(lt/hr)	% error = $\frac{I_a - I_m}{I_m} \times 100$

PROCEDURE:

1. At fully closed condition of the valve, note down the load in the tank and the Rota meter
2. Gradually open the valve and note down the level in the tank and Reservoir and also note down the Rota meter reading and the time taken for every 5 cm rise
3. Repeat the step 2 for different valve opening positions
4. At fully open condition, note down the reading
5. The graph is plotted between Percentage error and Indicated Reading

RESULT:

Thus the calibration of rotameter was done and the error graph is drawn.

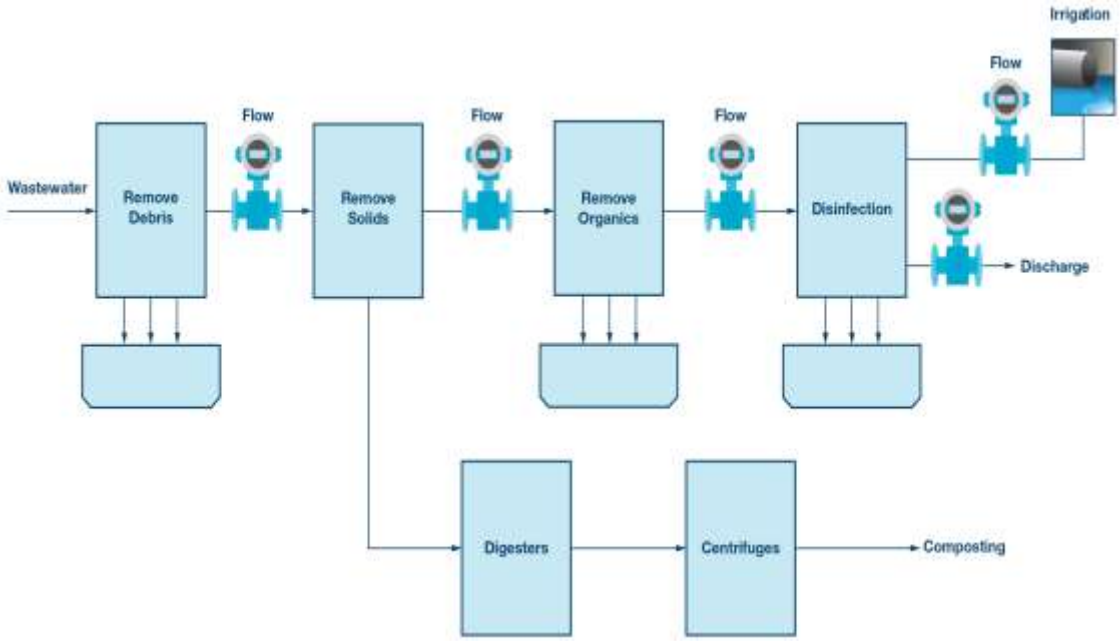


FIG. PIPE FLOW ARRANGEMENT

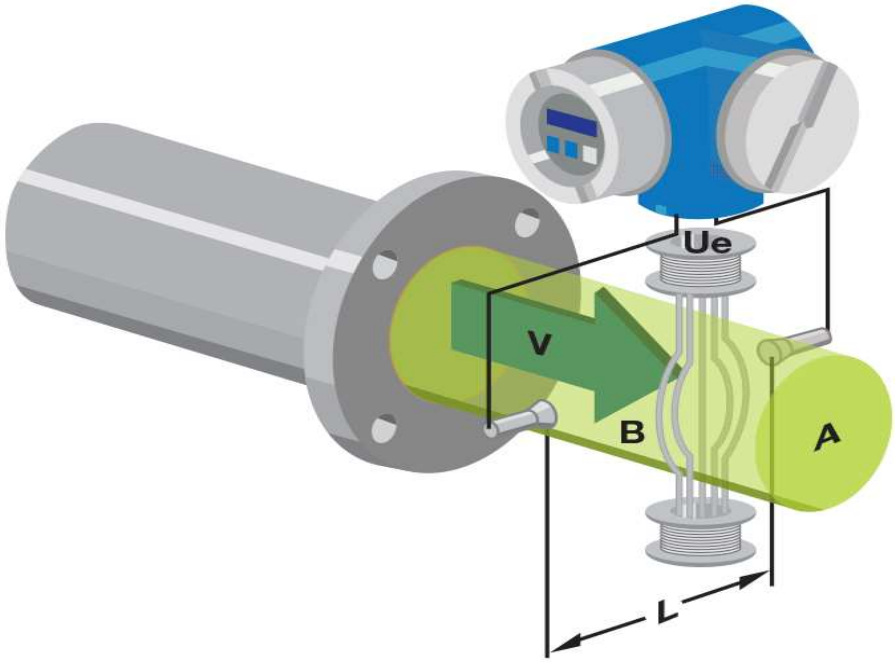


FIG. INSTALLATION OF ELECTROMAGNETIC FLOW METER IN PIPE.

6. DESIGN AND TESTING OF ELECTROMAGNETIC FLOWMETER

AIM:

To design and test the nature of the fluid flowing inside the pipe using electromagnetic flowmeter.

APPARATUS REQUIRED:

i) Flow pipe
ii) Electromagnetic flowmeter

THEORY:

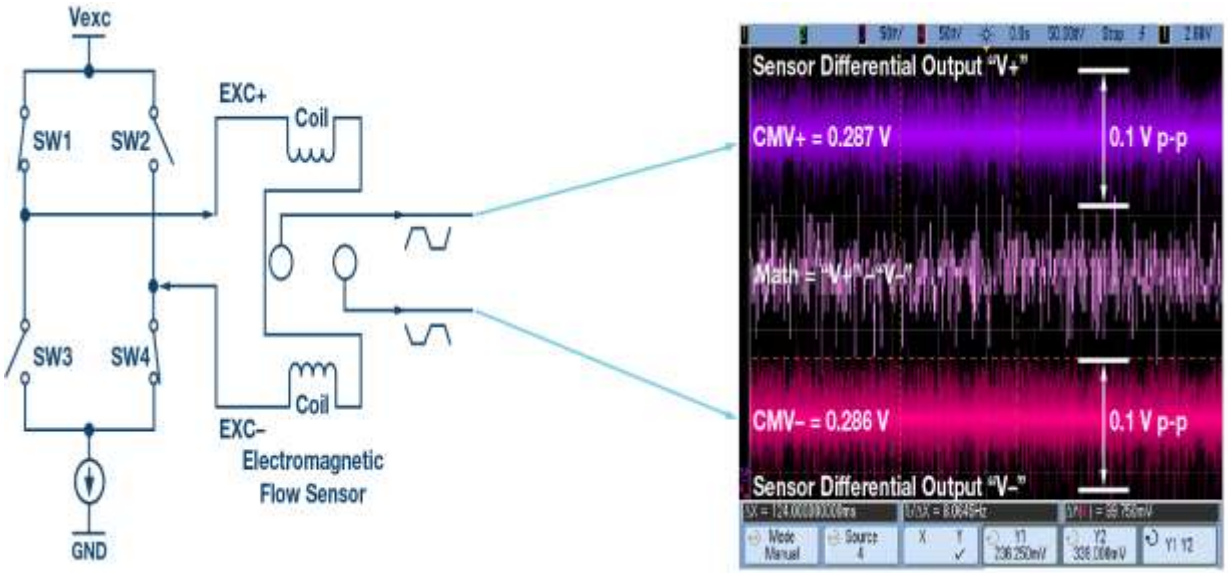
The working principle of a magnetic flow meter is based on Faraday's law of electromagnetic induction. According to Faraday's law, when the conductive fluid flows through a magnetic field of the sensor, an electromotive force proportional to the volume flow is generated between the pair of electrodes, which is perpendicular to the flow direction and the magnetic field. The amplitude of the electromotive force can be expressed as:

$$\mathbf{E = kBDv}$$

Where
E is the induced electric potential,
k is a constant,
B is the magnetic flux density,
D is the inner diameter of the measuring tube, and
v is the average velocity of the fluid in the axial direction of the electrode cross-section inside the measuring tube.

The Output Range of the Sensor.

The sensor has a differential output. Its sensitivity is typically 150 microvolts/(mps) to 200 microvolts/(mps). Since the excitation current alternates its direction, the sensor output signal amplitude doubles. For the flow rate measurement range of 0.5 meters/second to 15 meters/second, the sensor output signal amplitude ranges from 75 microvolts to approximately 4 mV to 6 mV. Figure 3 shows the sensor output signal when being excited with constant current source and with fluid flowing through the sensor. The scope plot captured on the sensor output leads shows a very low level signal sitting on significant common-mode voltage. The purple trace is for the positive electrode and the red trace is for the negative electrode. The pink trace is the math channel that subtracts the positive and negative electrodes. The low level signal sits in the significant common mode.



OUTPUT SIGNAL OF ELECTROMAGNETIC FLOW SENSOR.

RESULT:

Thus the flow rate of the fluid flowing inside the pipe was measured using electromagnetic flow meter.

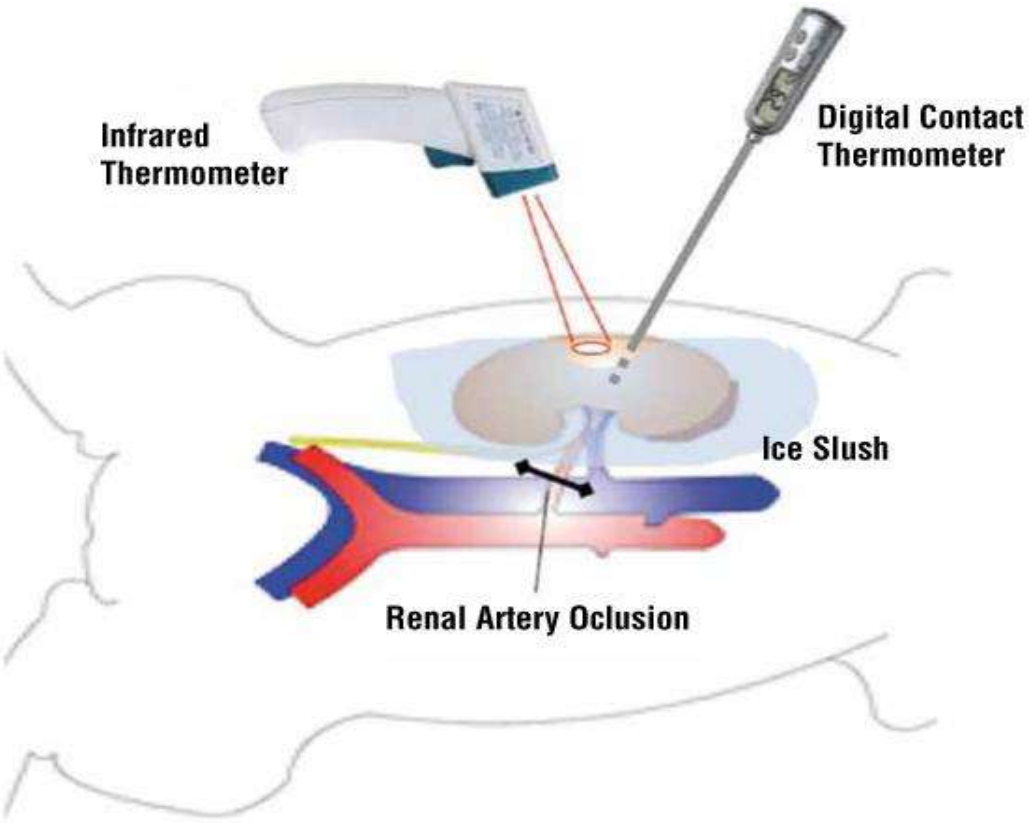
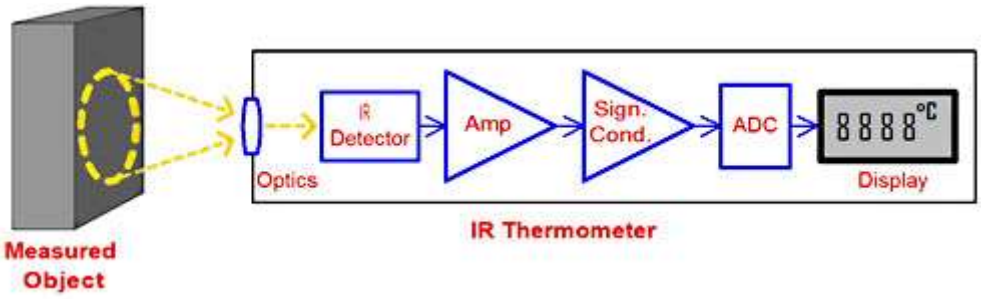


FIGURE. MEASUREMENT OF TEMPERATURE USING IR THERMOMETER



GENERAL BLOCK DIAGRAM

7. MEASUREMENT OF TEMPERATURE USING IR THERMOMETER AND IC SENSOR

AIM:

To measure the temperature of the fluid process using IR. Thermometer and IC sensor.

APPARATUS REQUIRED:

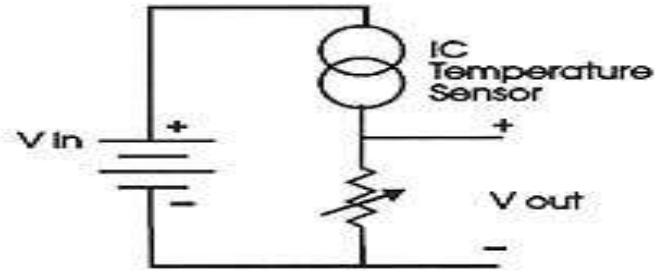
i) Fluid tank
ii) IR thermometer
iii) IC Sensor.

THEORY:

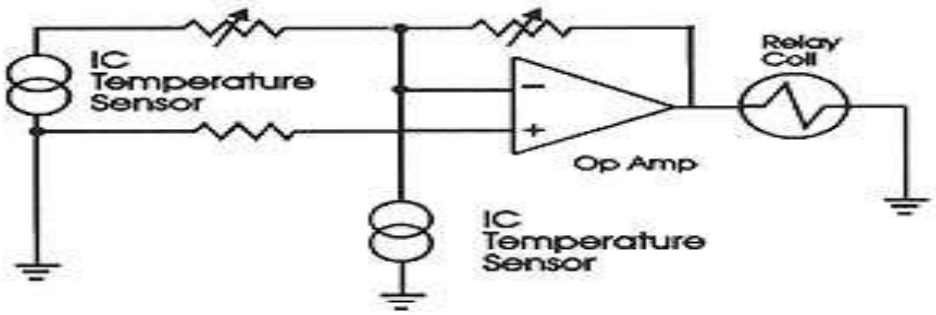
An infrared thermometer is a thermometer which infers temperature from a portion of the thermal radiation sometimes called black-body radiation emitted by the object being measured. They are sometimes called laser thermometers as a laser is used to help aim the thermometer, or non-contact thermometers or temperature guns, to describe the device's ability to measure temperature from a distance. By knowing the amount of infrared energy emitted by the object and its emissivity, the object's temperature can often be determined within a certain range of its actual temperature. Infrared thermometers are a subset of devices known as "thermal radiation thermometers".

Sometimes, especially near ambient temperatures, readings may be subject to error due to the reflection of radiation from a hotter body—even the person holding the instrument — rather than radiated by the object being measured, and to an incorrect assumed emissivity.

The design essentially consists of a lens to focus the infrared thermal radiation on to a detector, which converts the radiant power to an electricalsignal that can be displayed in units of temperature after being compensated for ambient temperature. This permits temperature measurement from a distance without contact with the object to be measured. A non-contact infrared thermometer is useful for measuring temperature under circumstances where thermocouples or other probe-type sensors cannot be used or do not produce accurate data for a variety of reasons.



a



b

CIRCUIT DIAGRAM FOR TEMPERATURE MEASUREMENT USING IC SENSOR

TABULAR COLUMN

Distance of the Object	Temperature in Deg

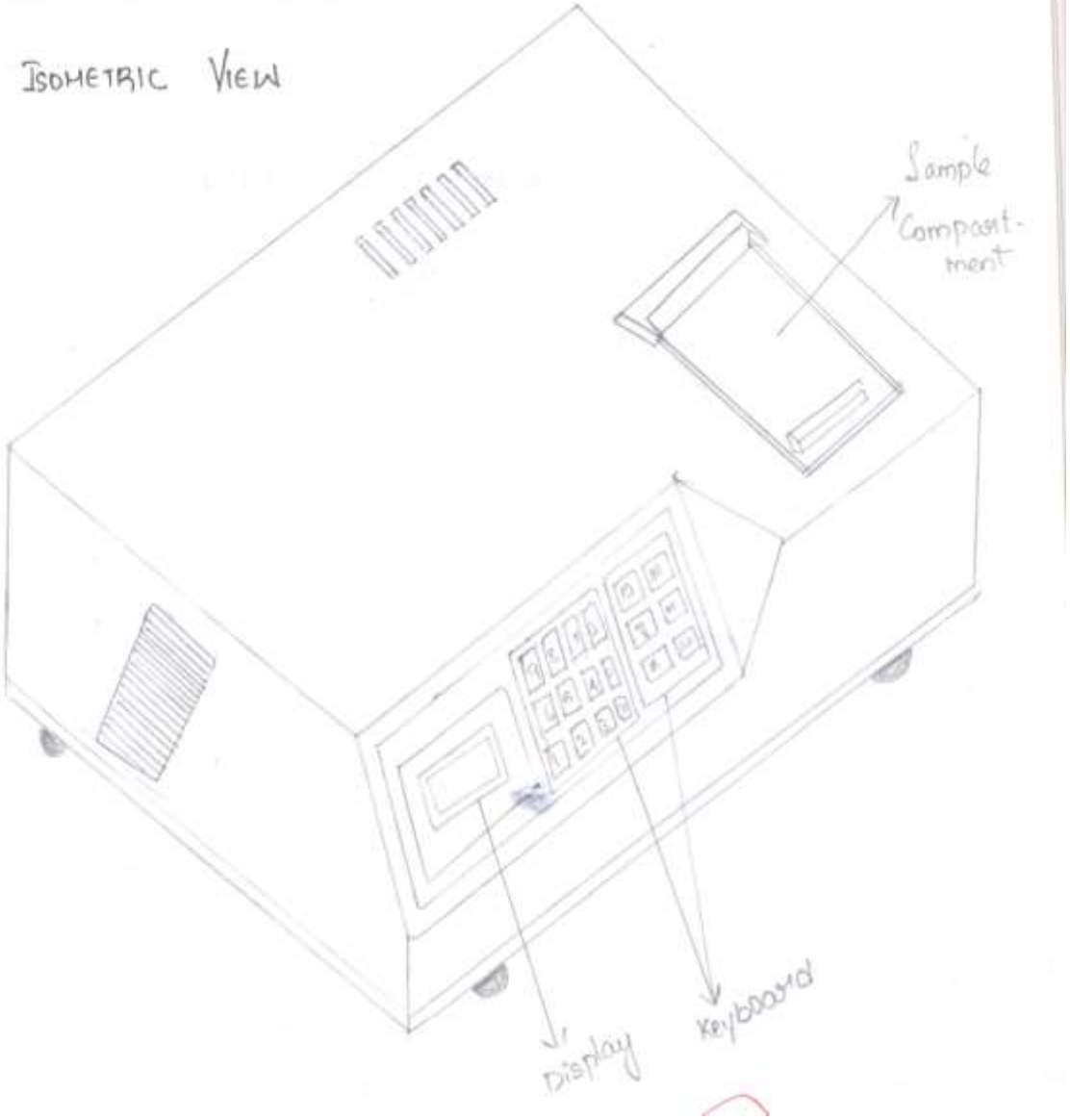
PROCEDURE:

- To prepare, choose a (full) can of a non-carbonated beverage; we find that canned lemonade works nicely.
- It's good to have a can with parts that are painted different colors, or that is only painted on part of the surface.
- Now, Place the can on a mug warmer to allow it to warm up to about 50° to 60 °C. If you have students work in groups, warm up one can for each group.
- The can is made of aluminum, which is a good thermal conductor; if you shake the can to mix up the liquid, the temperature of the liquid inside will be quite 3 uniform.
- The net result is that every point on the can is, to a very good approximation, at the same temperature. But that's not what your students will measure... •
- Give the students the warm can, and have them measure the temperature of different parts of the surface. Have them try the (painted) sides, the top, the bottom.
- Have them record the temperatures they observe.
- Let students know that, to a very good approximation, all parts of the outside of the can are, truly, at the same temperature.
- Ask your students to explain the odd results. Why do they measure different values from different points on the can? This is a good experiment for open-ended exploration. When students measure the temperature of a shiny surface, they'll pick up radiation from other sources that reflects from the can.
- And the curved bottom surface of the can will give different results depending on how far the thermometer is from the focal length of the concave mirrored surface. Ultimately, your students can determine what surfaces are good radiators, what surfaces are poor radiators. And they'll understand the thermometers well enough to set them up for further experiments in which they'll use these devices as an experimental tool.

RESULT:

Thus the temperature of the object was measured using IR Thermometer and IC sensor.

ISOMETRIC VIEW



8 UV SPECTROPHOTOMETER

AIM

To determine transmittance, Absorbance and concentration of the given complex solution using visible spectrophotometer.

APPARATUS REQUIRED

1. Spectrophotometer Unit
2. The Computer Unit

THEORY

PRINCIPLE OF OPERATION

Absorption spectrophotometry employed in the ultraviolent, visible and near infrared regions of the electromagnetic spectrum is based on the principle at each substance has characteristic properties which determines the wavelengths of radiation it absorbs. Each different atomic and molecular structure of a chemical substance has unique resonant frequency or enegry level. When the frequency of a particular wavelength of radiation directed into the substance coincides with the resonant frequency or energy level, its radiant energy is imparted to the substance. This phenomenon of energy transfer is referred as absorption.

Liquids and other transparent materials display color when they selectively absorb wavelengths of radiant energy in the visible region. This effect can be observed by the eye in the visible region, it exemplifies the absorption process in the ultraviolet and infrared regions. Distilled water appears colorless because none of the visible wavelengths are absorbed. However, addition of a small amount of red dye to the distilled water causes the solution to appear red because almost all of shorter wavelengths are absored and almost all those of the order of 650nm are transmitted. If a violet dye is added to the distilled water. The solution appear violet colored because almost all longer wavelengths will be absorbed and almost all wavelengths of order 400nm will be transmitted. When the amount of radiant energy transmitted or absorbed by a substance is plotted as a function of wavelength, the resultant curve is the spectrum of that substance.

The amount of radiant energy absorbed by a sample at a certain wavelength depends on how much of that substance, which absorbs that wavelength of radiation, is present in the sample. In other words, the absorpiton of radiant energy is proportional to the absorbing materials.

TRANSMITTANCE, ABSORBANCE AND CONCENTRATION

When light falls upon a homogeneous medium a portion of incident light is absorbed within the medium and the remaining portion is transmitted. It is the transmitted light that is actually detected by the instrument. Transmittance (T) is defined as the ratio of intensity of transmitted light and intensity of the light that is falling upon the sample. Tranmittance usually multiplied by 100 and is called as percent transmission (%1). Absorbance (A) is the logarithm to the base of 10 of the reciprocal of transmittance. Concentration is a relative figure compared to a known value of the sample.

The realtionship between transmittance and absorbance can be shown as, Po is the intensity of light incident upon the first surface of a sample and P the intensity of light that leaves the sample. From this information are derived the equations that relate transmittance and absorbance.

T (Transmittance of sample) = P / Po

A (Absorbance of sample) = log 10 1/T

These terms relate to rectilinear transmission of a single frequency of radiant energy through a homogeneous, isotropic, non-metallic medium with plane, smooth and parallel surfaces.

In analytical measurements, it is essential to compare the sample with reference and sample should be taken under identical conditions. For spectrophotometric analysis, the absorbance or transmittance readings are taken by place the sample in a cuvette. Therefore reference should be taken in identical cuvette. If the sample compound must be dissolved, or if it is only one constituent of mixture the duplicate reference cell is filled with the pure solvent or with the same mixture minus the sample compound. Thus, energy losses from reflection at the cell interfaces are the same with both reference and sample and usually can be ignored. The reference solution with which the sample is compared mut be specified when transmittance and absorbance data are presented.

Tabular Column:

Potassium Dichromate

Wavelength (nm)	Absorbance	%Transmittance (%)

Potassium chromate

Wavelength (nm)	Absorbance	%Transmittance (%)

QUALITATIVE ANALYSIS

In general, spectrophotometer identification of organic compounds is empirical. If information is available to permit tentative identification. A sample can be prepared in the approximate concentration and the absorption data gained from it can be compared with that of the unknown. If recorded spectra are available, absorption data of unknown sample can be compared with them. When making comparisons, the most important criteria are the shape of curves, the values, relative height and wavelength position of the maximum and minimum and the ratio of absorptivity at different wavelengths.

QUANTITATIVE ANALYSIS

Spectrophotometric Quantitative Analysis is generally concerned with samples in which the compounds are known and it is necessary only to determine their concentrations. Beer's law can be applied for the quantitative treatment of absorption of radiant energy by matter.

Quantitative analysis based upon Beer's law, which expresses the relationship between absorbance and concentration of a compound in solution. After derivation, Beer's law may be reduced to the equation.

$A = abc$ Where A = absorbance

$a = A/bc$ a = absorptivity constant

b = path length through sample in cm

c = concentration (gm/liter)

Absorbance is the property of a sample. It depends upon the wavelength of incident light, the temperature and the solvent employed. Absorptivity, a constant, is the property of substance. When the absorbance of a compound is directly proportional to the concentration, the compound follows Beer's law. In this case, it is possible to substitute values in the equation and to determine mathematically the concentration of a compound by comparing its absorbance with the absorbance of the same compound at known concentration. (The path length being the same in both cases, it cancels out in the calculations). If the absorbance of a compound follows Beer's law and a graph of absorbance versus conentration is plotted a straight line is obtained. However, there is slight deviation at the lower and higher concentrations. The strict linearity is followed between the absorbance values 0.18 to 0.65A.

DESCRIPTION OF THE SYSTEM

The P.C. based UV 5704SS Spectrophotometer consists of

a) Spectrophotometer Unit

b) The Computer Unit.

THE SPECTROPHOTOMETER UNIT

This unit accommodates the sources of radiation, the deuterium lamp for the UV region and the Tungsten-Halogen lamp for the visible and the near infrared region of the spectrum, the double beam optics for the collimation and dispersion of the light beam, the sample compartment, electronics circuitry for providing power supplies to the sources of radiation, for processing the signal from Detector. The dispersing element is a plane, blazed reflection type diffraction grating. The grating is rotated by a computer controlled stepper motor through a precise, anti backlash lead-screw nut pair. A fixed slit provides constant spectral bandwidth throughout the wavelength region. Filters are automatically introduced in the path of light beam by another stepper motor at specific wavelengths to minimize the stray light. The present sample holder can accommodate 10mm path length cuvettes. The sample compartment has been designed to accommodate large path length cells and also flow through cells.

The light signal coming out of the reference and the sample falls on solid state detector. The gain required for the amplifier is automatically adjusted by the computer for each wavelength to maintain a constant level of output through out the wavelength range. The preamplifier converts the current from the detector into a voltage proportional to the intensity of the light incident on the detector. The output of the amplifier is connected to the PC interface for further processing.

THE COMPUTER UNIT

The unit is a IBM compatible Pentium PC with 16MB RAM, IGM hard disk, one floppy disk drive, a color or a monochrome monitor, full ASCII keyboard, the specific hardware interface to achieve the various functions of the spectrophotometer.

The specific hardware interface plugged into one of the expansion slots in the PC containing the circuitry for driving the stepper motors, controlling the gain for the amplifier, the A/D converter for converting the signals from the amplifier and the necessary timing and control circuits necessary for interfacing to the PC-bus.

4.1.1
OPEN FILE

Select this option to load the spectrum from a file stored earlier. This option will display a dialog box with all the available data files (.trs or .abs extension) from which required file can be selected to load.

To select a file just click on the correct file name and select the OK button or double click the file name. At the top right of the screen menu appears a Load button. Selecting this button enables the user to analyze the stored spectrum elementally on selecting a stored file, along with the spectrum the wavelength in steps of 0.5mm span, corresponding Transmittance and absorbance are displayed throughout the range of the spectrum. On selecting the Clear button from the main menu clears the spectrum analyzed.

4.1.2
PRINT

To print the displayed data on the paper, this option is selected. Make sure that the printer is connected and the paper is loaded before selecting this option. Similarly a stored file can be opened and print command can be selected for printout.

4.1.3
PRINT PREVIEW

Selecting this command gives an idea to the user the hardcopy to be printed.

4.1.4
PRINT SETUP

Selecting this command the user has a choice to check the print quality, the orientation of the printout (spectrum) and the printer.

4.1.5
EXIT

Selecting this option will close this software permanently. If the user wants to re-enter run this software again.

4.2
VIEW

This menu item contains the following sub menu.

4.2.1 Status Bar

4.2.2 Tool Bar

4.2.1
STATUS BAR

Shows or hides the status bar.

4.2.2
TOOL BAR

Shows or hides the tool bar. Tool bar appears in program and provide quick way to do task. Most tool bar buttons corrrespond to a menu command. You can find out what each button does by resting your pointer over the button. A box appears displaying the button name.

4.3
POWER *ON/OFF*

Selecting this item ⊙ will switch on/off the power supply to the unit (TOGGLE). Throughout the period the user is in DBS_SS at all levels of menus the failure of the instrument is indicated at the lower right corner of the screen. The failure of the system *ON/OFF* and failure to both sources of tradition *ON/OFF* are also indicated.

4.4
INSTRUMENT

This menu item contains a sub-menu as given below:

4.4.1 Index

4.4.2 Peaks

4.4.3 EHT

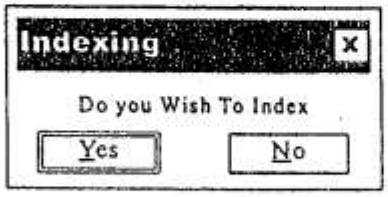
4.4.4 Baseline

4.4.1
INDEX

1) Selecting this menu item [I] Indexes system.

2) In case of power failure when DBS_SS is scanning sample or adjusting the wavelength, the software looses track of the wavelength, the user is expected to do index.

3) The menu will display a selection dialog box as shown below.



4) In D_lamp ON condition click Yes.

5) Indexing takes place.

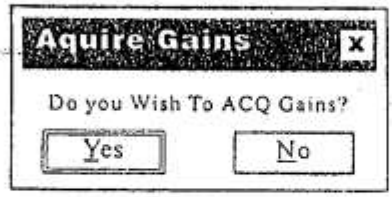
6) Indexing takes about 2 to 3 minutes.

4.4.2
PEAKS

4.4.2.1 : 656.3 nm /\ Checks the 656.3 nm calibration peak and display 656.3 nm peak.

4.4.2.2 : 486.1 nm /\ Checks the 486.1 nm calibration peak and displays the 486.1 nm peak.

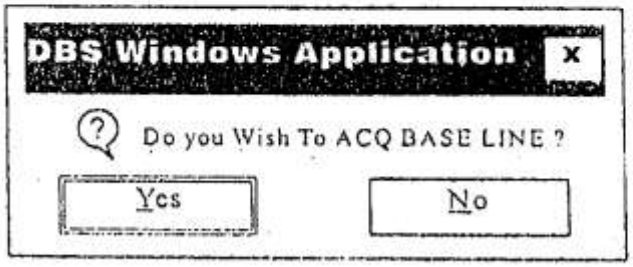
G us : On selecting this menu item xx displays a dialog box as shown below.



This option is to acquire Gains data which is required to keep the amplifier at a constant energy level for both reference and sample paths with Air in both channels. This option stores the gains data through the entire range in both sources in ON condition. Generally the userr is advised not do often as thid data is not critical for good performance of the system. On clicking OK with mouse the DBS_SS acquires Gains data and stores in a file. This process may take 4 to 5 minutes.

4.4.4
BASELINE

This function corrects the mismatch in reference and sample readings with Air in both paths. This function is evoked whenever the observed readings are deviated from 100%T or 0 ABS when both sample and reference paths have Air in both paths. The software DBS_SS corrects the mismatch throughout the wavelength range with both sources of radiation in ON condition. On selecting this option[: displays a dialog box as shown in the figure below.



On clicking OK the software corrects and updates the mismatched data and stores in a file. This may take 2 to 3 minutes.

4.5
APPLICATION

This means item contains a sub-menu as given below:

4.5.1 Wavelength Scan

4.5.2 Fixed Wavelength Studies

4.5.3 Time Scan

4.5.1
WAVELENGTH SCAN

This is the menu item from which actual scanning of the samples takes place for a particular range of wavelength (UV-VIS or both) in scan mode. This menu item as shown below, includes setting the parameters like wavelength range, No. of samples, Analyst identification, sample identification and mode of scan.

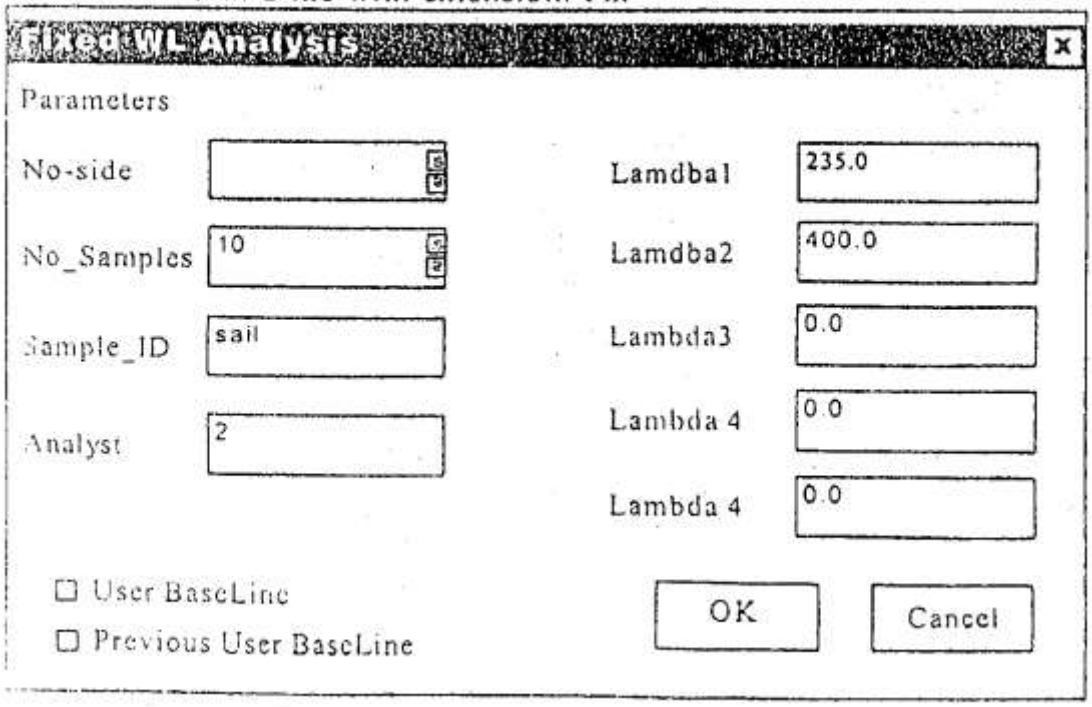
at which the solution exhibit peak or valley points in O.D. values. The user may thus only be interested in seeing the samples at fixed wavelengths in different concentrations. To facilitate the user to do quantitative analysis of samples the fixed scan of DBS_SS software is realized. The term fixed is derived from the situtation where No. of samples are analyzed at fixed wavelengths rather than scanning over a range. Multi wavelengths can also be chosen. To invoke the Fixed menu, the user should select one of the four possibilities from the dialog box (as shown below).

4.5.2.1	Absorbance
4.5.2.2	Linear
4.5.2.3	K-Factor
4.5.2.4	Quadratic

4.5.2

ABSORBANCE

Selecting this option A the user does away from concentration calculation. The wavelengths at which the samples are to be read, analyst identification, Sample-ID, No. of samples to be read are to be entered by the user. If on line baseline correction is required click User Base Line Box. Otherwise system base line will be applied by default. On pressing OK the DBS_SS software reads the samples at each wavelength or single wavelength as selected earlier and displays the readings. The readings can be stored in a file with extension. Fix



and analyzed at any time. Hard copy can also be taken. With the same set parameters if user wants to read some more samples click "Previous user base line" before proceeding with the samples.

4.5.2.2

LINEAR ANALYSIS

The linear mode is used for measuring concentration. The relationship between Concentration and Abs are established as shown below.

Conc = P1*Abs + Po

Where PI and P0 are the coefficients calculated from the readings of the standards fed to the system based on Least Square Method of Estimation. When Linear is selected the user has to give the number of standards to be fed to the system for linear regression. Minimum of 3 standards are to be entered and a maximum of 10 standards with identity can be entered.

On selecting Linear (as shown in the figure above for Absorbance Analysis), the user is expected to enter the standards concentration with identity according to the ascending values of concentration. After the software reading the standards, a calibration curve appears on the right hand side of the screen. Then the software prompts the user to place the samples and reads the samples by the click on OK. After the samples are read, the concentration values of samples, %T, Abs, sample_Id and wavelength(s) are displayed. The values of standards and samples can be stored in a file with extension fix. A hard copy of the readings can be taken with the same set parameters if user wants to perform linear analysis click "Previous user base line" before proceeding with the samples.

4.5.2.3

K-FACTOR ANALYSIS

When K-factor is selected kf (as shown in the figure for Absorbance Analysis) the user has to enter the value of a prroportionally constant and the concentration of the samples measured will be

Conc = P1*Abs

When this option is activated, the value of proportionally is to be entered. Then the procedure to read samples is same as described in Absorbance. With the same set parameters if user wants to analyze some more samples click"Previous user base line" before proceeding with the samples

4.5.2.4

QUADRATIC ANALYSIS

The quadratic mode is also used for measuring the concentration of unknown samples. The difference between linear and quadratic analysis is that in quadratic, the equation governing the relationship between the concentration and absorbance is

Conc = P0 + P1*Abs + P2* (Square of Abs)

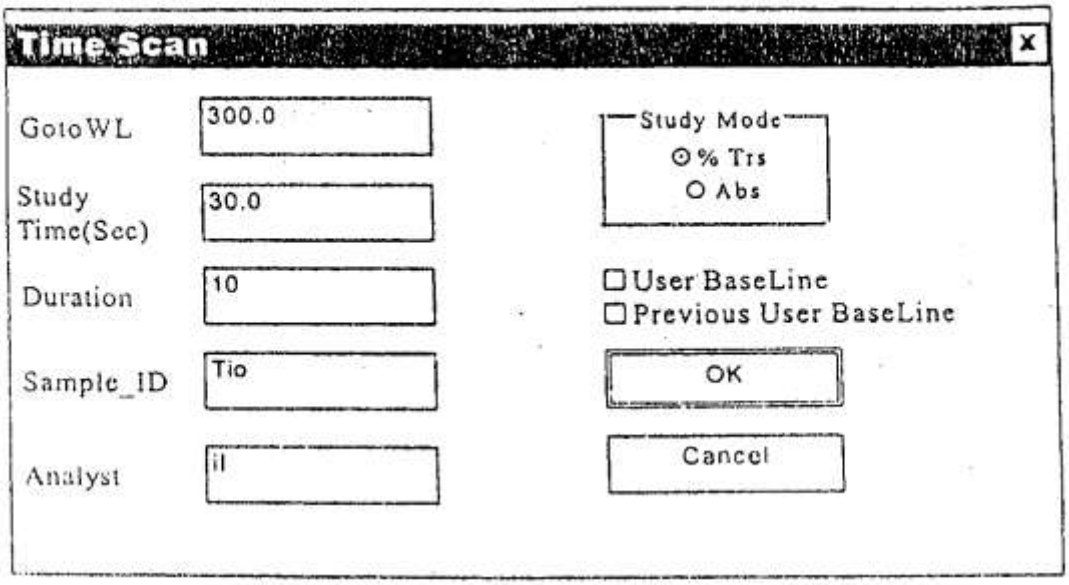
Where P0, P1 and P2 are the values of the coefficients calculated based on the on Least Square Method of Estimation from the values of the standards read.

The procedure to read standards and unknown samples is same as described in the case of Linear type of concentration evaluation. All the measurements written in fixed mode are for single wavelength and concentration of unknown samples can also be done at multiple wavelengths. With the same set parameters if user wants to repeat the Quadratic Analysis clikc "Previous user base line" before proceeding with the samples.

4.5.3

TIME SCAN

DBS_SS offers the user to study chemical samples which vary their O.D. values with respect to time after initiating a clock reaction. On selecting Time Scan option (as shown in the figure below), the user is expected to fill the queries such as time the sample is to be studied, sample identify, analyst ID, and the mode of study (%T or Abs), User Base Line and click OK. With the same set parameters if user wants to study some more samples click "Previous user base line" before proceeding with the Time Scan.



The plot scale is indicated with time in Sec on X-axis and the mode of study on Y-axis. The ordinate value is plotted against time in real time on the screen. The mode of study, sampling duration between each readings ae displayed on the right side of the screen.

4.6

CALCULATION

This menu item changes the display mode from transmittance to absorbance and vice-versa. This menu contains a sub menu item as shown below.

4.6.1

TRANSMITTANCE

4.6.2

ABSORBANCE

4.6.1

TRANSMITTANCE

Selecting this option the software display the acquired or stored spectrum in transmittance mode. To view the I and II derivative of the acquired spectrum click %T sub menu in calculation menu.

4.6.1.1

DER I

Selecting this option the software displays the 1 Derivative of the acquired spectrum in transmittance mode.

4.6.1.2

DER II

Selecting this option the software displays the II Derivative of the acquired spectrum in transmittance mode. In case of stored spectrum, retrieve the spectrum and follow the above procedure.

4.6.2

ABSORBANCE

Selecting this option will draw the spectrum in absorbance mode.

4.6.2.1 & 4.6.2.2

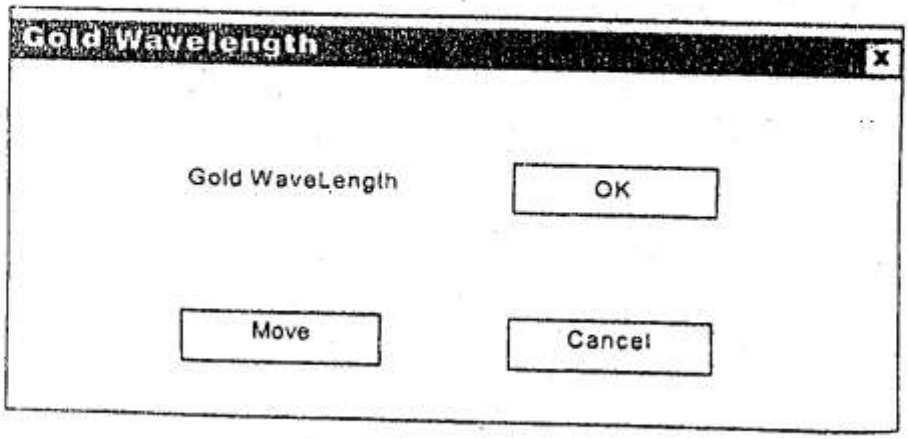
DER I & DER II

The procedure is same as that of I and II derivatives of Transmittance.

4.7

GO_WL

This option is to set the system at the desired value at which the O.D. concentration of the samples is to be measured. In the display box (as shown in the figure below) enter the wavelength at which the system is to park and click OK.



4.8

CLEAR

This option enable the software to clear the screen.

4.9

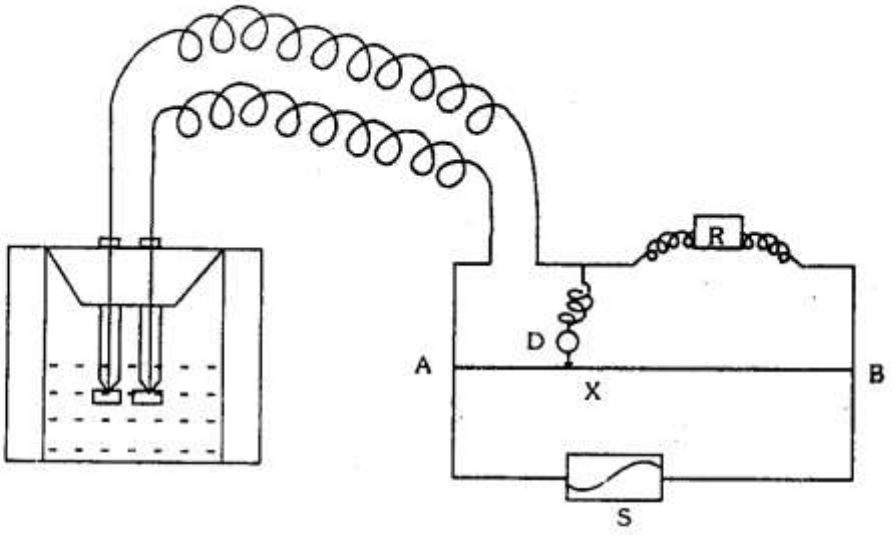
STOP

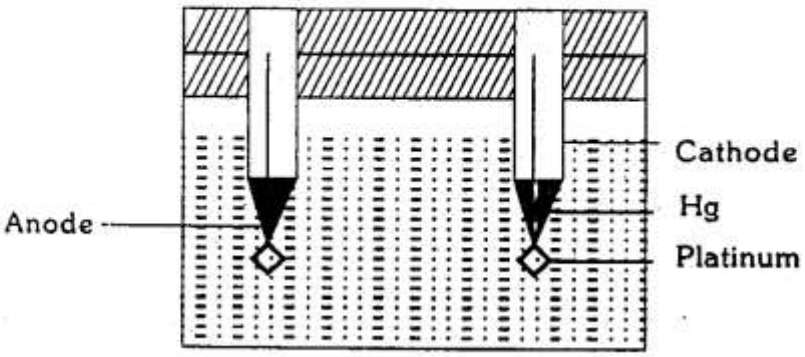
This option enable the user to terminate the application during the process.

RESULT

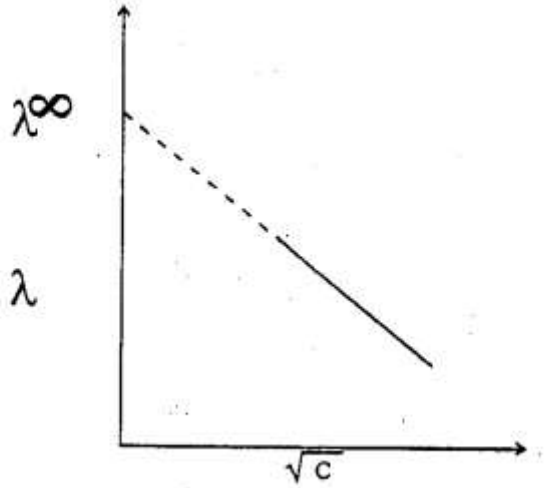
Thus determined the transmittance, absorbance and concentration of the complex solution.

CONDUCTIVITY MEASUMENT SETUP





MODEL GRAPH



9.A. CONDUCTIVITY MEASUREMENT

AIM:

To determine the equivalent conductance of sample solution using a conductivity cell.

APPARATUS REQUIRED:

i) Conductivity meter with conductivity cell.
ii) Nacl solution
iii) HCL solution.
iv) CH3 COONa solution.

THEORY:

An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

The common laboratory conductivity meters employ a potentiometric method and four electrodes. Often, the electrodes are cylindrical and arranged concentrically. The electrodes are usually made of platinum metal. An alternating current is applied to the outer pair of the electrodes. The potential between the inner pair is measured. Conductivity could in principle be determined using the distance between the electrodes and their surface area using the Ohm's law but generally, for accuracy, a calibration is employed using electrolytes of well-known conductivity.

Industrial conductivity probes often employ an inductive method, which has the advantage that the fluid does not wet the electrical parts of the sensor. Here, two inductively-coupled coils are used. One is the driving coil producing a magnetic field and it is supplied with accurately-known voltage. The other forms a secondary coil of a transformer. The liquid passing through a channel in the sensor forms one turn in the secondary winding of the transformer. The induced current is the output of the sensor.

PROCEDURE:

1 Connect the conductivity cell to the socket on the I/P side of the meter.\
2 Prepare a conductivity solution of approximately the same value as the solution to be measured. The solution is to be prepared at 25°C.
3 Set the meter to the µs/cm or TDS mode.
4 Place the cell in the calibration solution and allow the reading to stabilize.
5 Adjust the cell knob until the display reads the value of the calibration solution.
Eg: For a 12560 µs/cm conductivity solution the display will read 1256.The user must multiply the reading by 10.

Tabulation

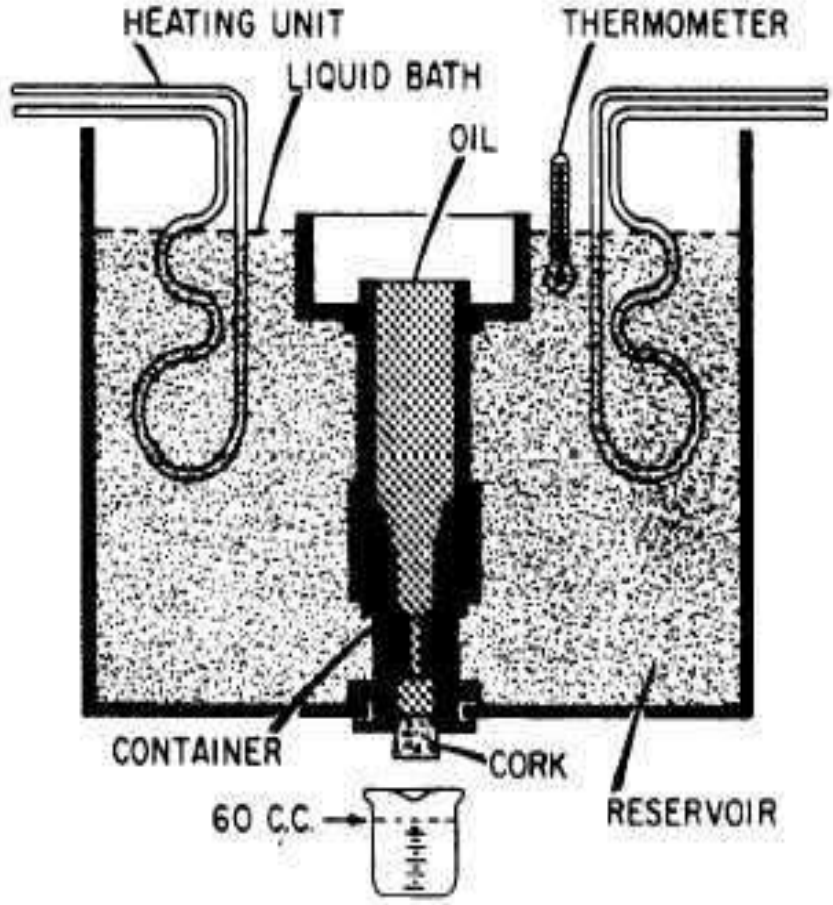
S.No	Volume of NAOH(ml)	Conductance 1/R(mΩ)

CONDUCTIVITY/TDS MEASUREMENT (Multiply by 10):

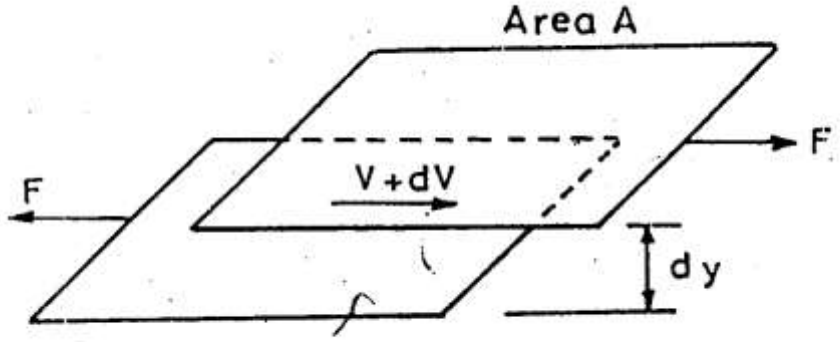
1 Place the electrolyte in the sample solution and note the reading.
2 When finished, unplug the electrode or cell and rinse it in distilled water.
3 Exactly 0.1N solution of the given solution are prepared by taking different volumes of the 0.1N HCL solution of the given solution and it is diluted to attain a range of concentration such as 0.01,0.02,0.03,0.04 etc.
4 The conductance of each solution is determined by taking in conductivity cell and connecting it to a conductivity bridge from the value of the conductance measured of a particular concentration solution, its equivalent conductance is calculated.
5 A graph is drawn between the conductance and $\sqrt{C}$ by extrapolating towards the Y axis equivalent conductance is obtained.

RESULT:

Thus the equivalent conductance of sample solution was determined.



EXPERIMENTAL SETUP OF SAYBOLT VISCOMETER



Dig:7. Movement of plane with respect to another and the concept of dynamic viscosity.

9. B I) MEASUREMENT OF VISCOSITY BY SAYBOLT VISCOMETER

AIM:

To determine Kinematic and absolute viscosity of a given sample of oil and to study the variation of viscosity with temperature.

APPARATUS REQUIRED:

Say bolt Viscometer, Thermometer, Stop watch and 60cc Flask.

THEORY:

Viscosity is an internal property of a fluid to offer resistance to its movement. Thinner the liquid the lesser would be its viscosity and thicker the liquid the greater would be its viscosity. Thus the viscosity describes a fluid's internal resistance to flow and may be thought of as a measure of fluid friction.

Types of fluids:

Primarily there are two types of fluid and it depends on the relationship between the viscosity and the force. They are,

i) Newtonian fluids:

A Newtonian fluid is a fluid whose stress versus strain rate curve is linear and passes through the origin (Or) many fluids undergo continuous deformation with the application of the shearing stress (force) such that this force produces a movement (flow) and if the force-flow relation is linear, the fluid is referred to as Newtonian fluid.

A Newtonian fluid obeys Newton's law of viscosity

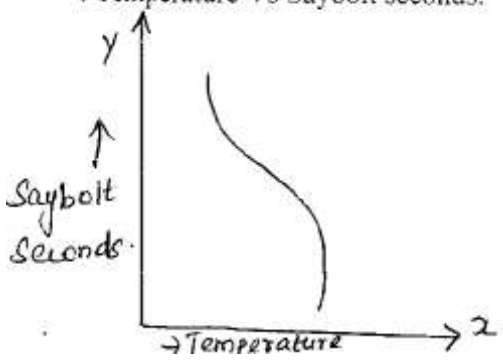
i.e., $\tau = \mu \, dV/dy$
Where, τ = Shear stress
μ= Coefficient of viscosity
dV/dy = Velocity gradient

ii) **Non- Newtonian fluids:**

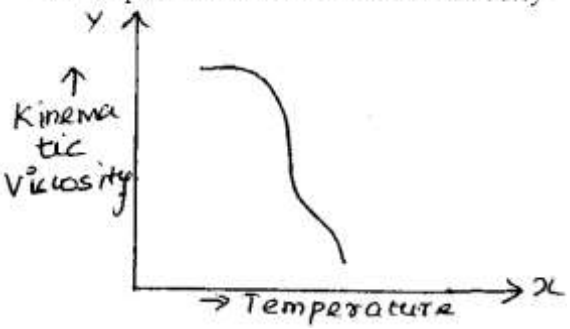
A non-Newtonian fluid is the one whose force-flow relation is not only non-linear but also changes from material to material. Moreover it does not obey Newton's law of viscosity.

MODEL GRAPH

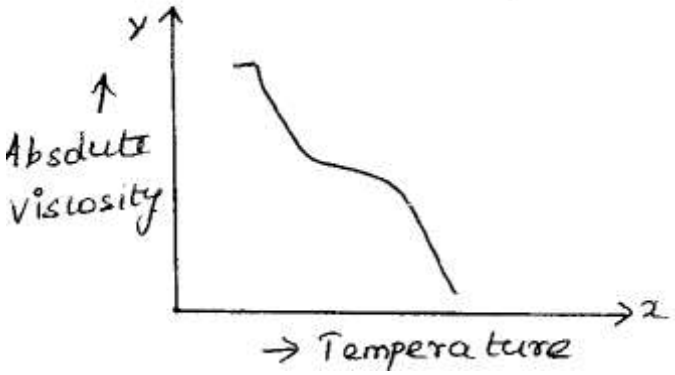
1 Temperature Vs Saybolt seconds.



2 Temperature Vs Kinematic viscosity



3 Temperature Vs Absolute viscosity.



TABULATION:

Temperature T (°C)	**Saybolt Sec (t)**	ρ_t **gm/cc**	**Kinematic Viscosity (Centi-strokes)**	**Absolute viscosity (Centi-poise)**

Types of Viscosity:

Consider a plane of area A in a fluid as shown in the diagram. It is moving with a velocity of V+dVAparallel plane in the fluid at a distance dy from the first planes moving with a velocity of V so that the relative velocity is dV. The change in the velocity, dV, is due to the shear stress τ caused by forces at the faces exerted by adjacent solid surfaces or fluid.

i) For an ideal Newtonian fluid,

Shear Stress

Absolute or Dynamic viscosity μ = Velocity gradient

$= \tau / (dv/dy)$

$= (F/A)/(dv/dy)$

Where F=Shearing force on area A; N.

The SI unit for dynamic viscosity is Ns/m^2.

ii) **For an ideal Newtonian fluid,**

Absolute viscosityμ

Kinematic viscosity v = Density = ρ

The unit of kinematic viscosity in SI system is m^2/s.

FORMULA:

i) Kinematic viscosity $\gamma = [At - B/t]$ centi stroke

Where, $A = 0.0024 \times 10^{-3}$, $B = 1.7 \times 10^{-3}$ and t = Say bolt seconds.

ii) Absolute viscosity = μ = Kinematic viscosity x Density

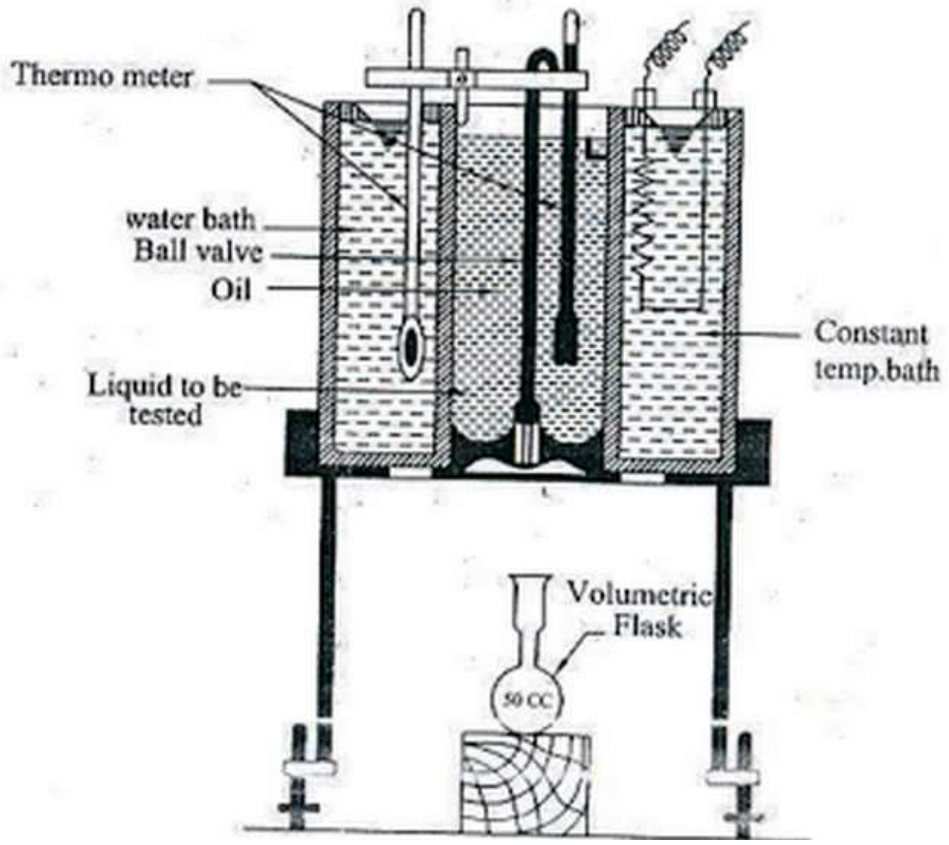
$= \gamma \times \rho_t$

Where, $\rho_t = \rho_R \times [1 - 0.00065 \times (T - t_R)]$, t_R = Room temperature and $\rho_R = 0.831$gm/cc.

PROCEDURE:

1. Clean the cup and make sure that the jet is clean from dirt.
2. Close the orifice with the valve and fill the cup with the given oil.
3. Insert the thermometer in the holder.
4. Place the 60 cc standard flask below the opening of the orifice.
5. Adjust the flask so that the stream strikes the mouth of the flask to avoid foaming.
6. Heat the oil by switching on the heater and the water bath is stirred by using the heater continuously.
7. Care must be taken so that the temperature of the bath does not exceed the temperature of the oil.
8. Cut-off the heater supply while taking the readings.
9. Lift the valve when the oil has attained the desired temperature and then collect the oil in the 60 ml flask.
10. Note the time taken for the collection of 60 ml of oil.

RESULT: Thus the kinematic and absolute viscosity of the given oil and its variation with temperature was determined



EXPERIMENTAL SET UP OF REDWOOD VISCOMETER

9. B. II) MEASUREMENT OF VISCOSITY BY REDWOOD VISCOMETER

AIM:

To determine the kinematic and absolute viscosity of a given sample of oil and to study the variation with temperature

APPARATUS REQUIRED:

Red wood Viscometer, Thermometer, Stop watch and 50cc Flask.

THEORY:

Viscosity is the measure of the relative resistance between layers of flowing fluid. It is due to the cohesive force between the molecules contained in it. Viscosity of a liquid decreases with temperature and that of the gas increases with it.

Viscosity is an internal property of a fluid to offer resistance to its movement. Thinner the liquid the lesser would be its viscosity and thicker the liquid the greater would be its viscosity. Thus the viscosity describes a fluid's internal resistance to flow and may be thought of as a measure of fluid friction.

Types of fluids:

Primarily there are two types of fluid and it depends on the relationship between the viscosity and the force. They are,

i) Newtonian fluids:

A Newtonian fluid is a fluid whose stress versus strain rate curve is linear and passes through the origin (Or) many fluids undergo continuous deformation with the application of the shearing stress (force) such that this force produces a movement (flow) and if the force-flow relation is linear, the fluid is referred to as Newtonian fluid.

A Newtonian fluid obeys Newton's law of viscosity

i.e., $\tau = \mu \, dV/dy$
Where, τ = Shear stress
μ= Coefficient of viscosity
dV/dy = Velocity gradient

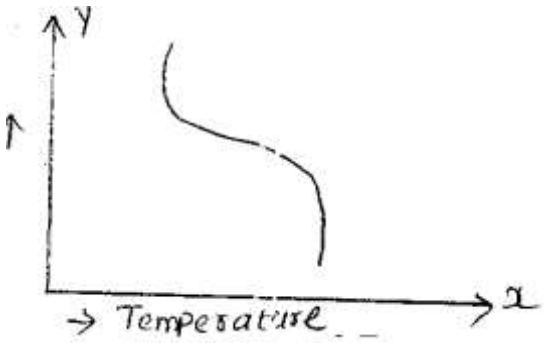
ii) **Non- Newtonian fluids:**

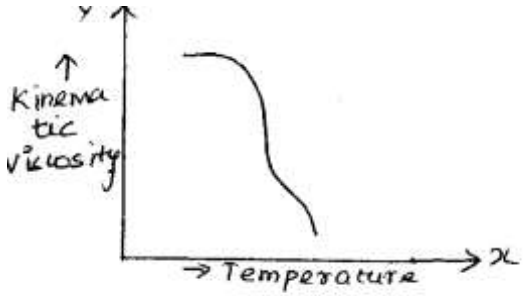
A non-Newtonian fluid is the one whose force-flow relation is not only non-linear but also changes from material to material. Moreover it does not obey Newton's law of viscosity.

MODEL GRAPH

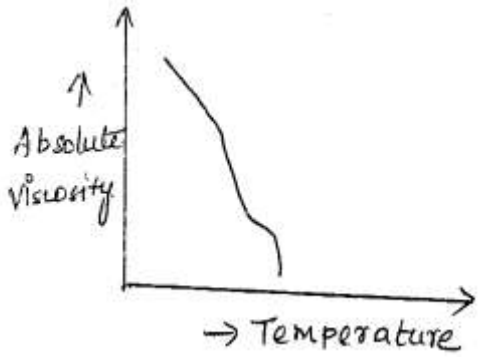
1 Temperature Vs Redwood seconds.2 Temperature Vs Kinematic viscosity

Redwood seconds.





3 Temperature Vs Absolute viscosity



TABULATION:

Temperature T (°C)	**Redwoodt (sec)**	**Density ρ_t (gm/cc)**	**Kinematic Viscosity (Centi-strokes)**	**Absolute viscosity (Centi-poise)**

Types of Viscosity:

Consider a plane of area A in a fluid as shown in the diagram. It is moving with a velocity of V+dVA parallel plane in the fluid at a distance dy from the first plane is moving with a velocity of V so that the relative velocity is dV. The change in the velocity dV is due to the shear stress τ caused by forces at the faces exerted by adjacent solid surfaces or fluid.

i) For an ideal Newtonian fluid,

Shear Stress

Absolute or Dynamic viscosity μ = Velocity gradient

$= \tau / (dv/dy)$

$= (F/A)/(dv/dy)$

Where F=Shearing force on area A; N.

The SI unit for dynamic viscosity is Ns/m^2.

ii) For an ideal Newtonian fluid,

Absolute viscosityμ

Kinematic viscosity v = Density = ρ

The unit of kinematic viscosity in SI system is m^2/s.

FORMULA:

iii) Kinematic viscosity $\gamma = [At - B/t]$ centi stroke

Where, $A = 0.0026 \times 10^{-3}$, $B = 1.7 \times 10^{-3}$ and t = Redwood seconds

Absolute viscosity = μ = Kinematic viscosity x Density

$= \gamma \times \rho_t$

Where, $\rho_t = \rho_R \times [1 - 0.00065 \times (T - t_R)]$ gm /cc, t_R = Room temperature and $\rho_R = 0.831$gm/cc.

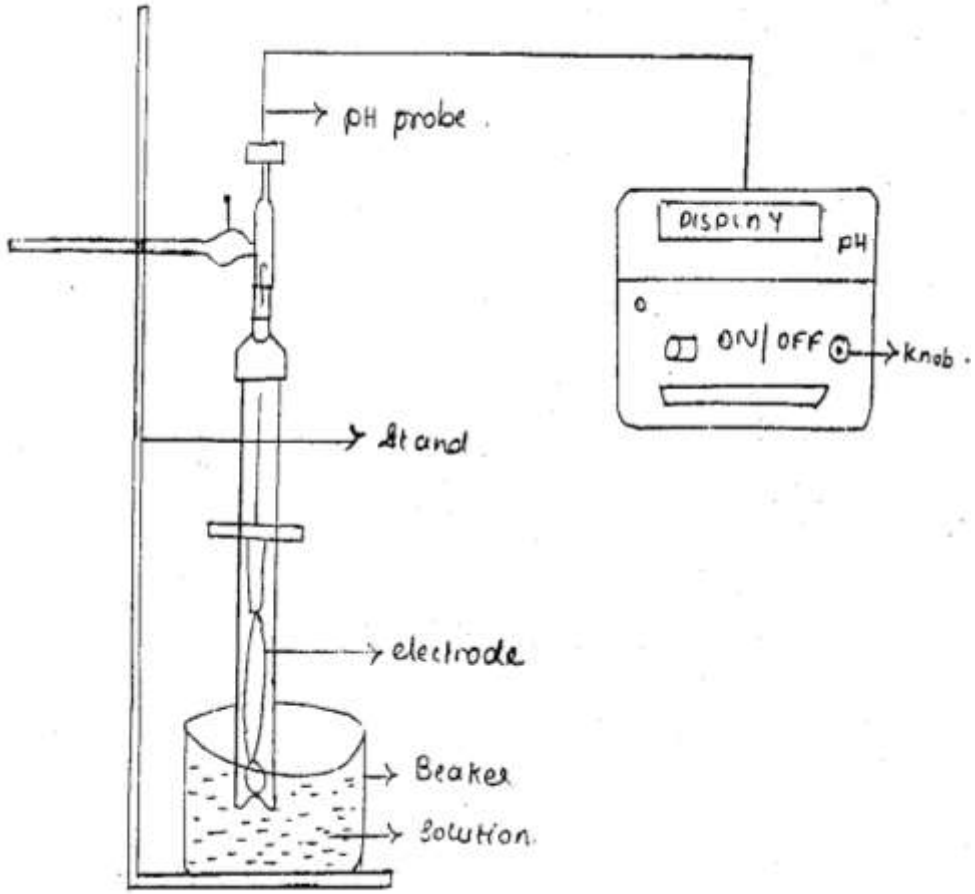
PROCEDURE:

1. Clean the cup and make sure that the jet is clean from dirt.
2. Close the orifice with the valve and fill the cup with the given oil.
3. Insert the thermometer in the holder.
4. Place the 50 cc standard flask below the opening of the orifice.
5. Adjust the flask so that the stream strikes the mouth of the flask to avoid foaming.
6. Heat the oil by switching on the heater and the water bath is stirred by using the heater continuously.
7. Care must be taken so that the temperature of the bath does not exceed the temperature of the oil.
8. Cut-off the heater supply while taking the readings.
9. Lift the valve when the oil has attained the desired temperature and then collect the oil in the 50 cc flask.
10. Note the time taken for the collection of 50 cc of oil.

RESULT:

Thus the kinematic and absolute viscosities of the given oil and its variation with temperature have been determined.

EXPERIMENT SET UP OF pH MEASUREMENT



TABULATION:

SAMPLE SOLUTION	**pH VALUE**
DILUTE HCL (ACID)	
DISTILLED WATER (NEUTRAL)	
NAOH (BASE)	

10. STANDARDIZATION AND MEASUREMENT OF pH VALUESOF DIFFERENT SOLUTIONS

AIM:

To measure the pH value for the given solution.

APPARATUS REQUIRED:

pH meter with pH sensor, buffer solution with known pH value and solution of unknown pH value.

THEORY:

A pH meter is an electronic instrument that consists of a special measuring probe (Glass electrode) connected to an electronic meter in order to measure and display the pH value. pH is a measure of the acidity or basic of an aqueous solution. Pure water is said to be neutral, with a pH close to 7.0 at 25 °C (77 °F). Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline.

The pH of any solution is a direct indication of the amount of hydrogen ion concentration. The pH, may be defined as negative logarithm to base 10 of the reciprocal of the hydrogen ion concentration.

$$pH = - \log_{10} [H^+] = \log_{10}[1/H^+]$$

The measurement of pH value is done by immersing a pair of electrodes i89nto the solution under test and measuring the voltage developed across them. One o9f the electrodes used in a pH cell is called reference electrode and is kept at a constant potential regardless of the pH value of the solution under test. The other electrode is called measuring electrode, the potential of which is determined by the pH value of the solution. Thus the potential difference between the reference and the measuring electrode becomes a measure of the pH value of the solution under test.

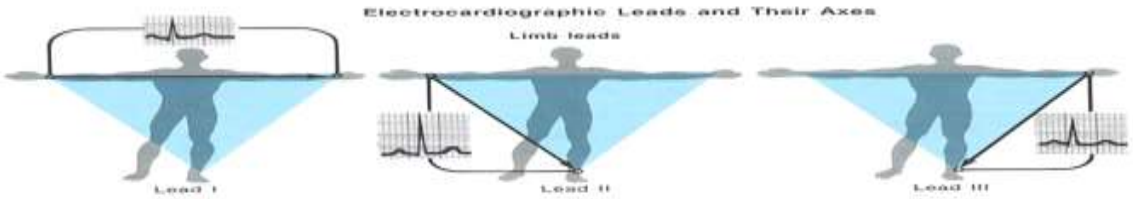
PROCEDURE:

1 Switch on the pH meter.
2 .Connect the glass electrode to the pH meter.
3 Rinse the pH electrode with distilled water.
4 Insert the pH electrode in the beaker with sample solution.
5 Note down the pH Value from the display of pH meter.
6 The pH meter should display the pH value which should be < 7 if the solution is acidic and will be > 7 if the solution is alkaline in nature.

RESULT:

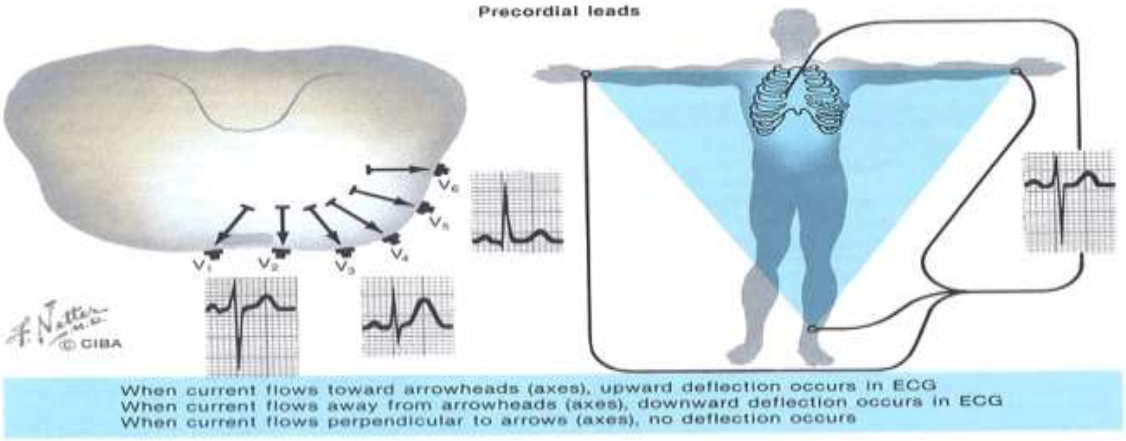
Thus the pH value of the solution was tabulated.

ECG Limb Leads

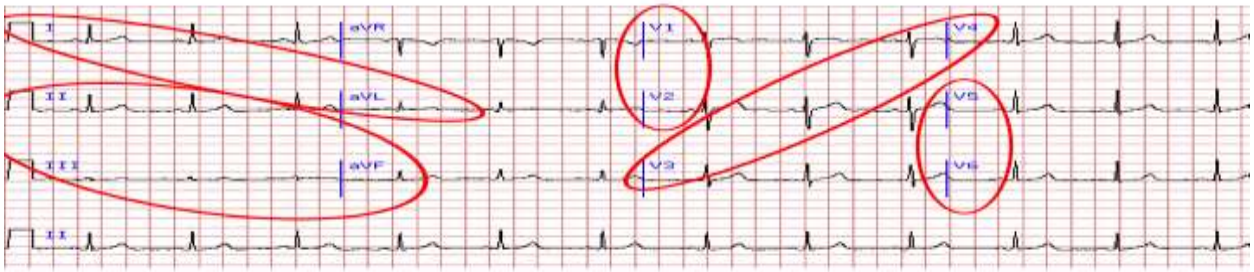


ECG Augmented Limb Leads

ECG Precordial Leads



The 12 lead ECG:



11.A. STUDY OF ECG MEASUREMENT

AIM:

To study to trace the ECG waveform and measure the various time interval and amplitude of ECG waveform to make a diagnosis.

APPARATUS REQUIRED:

ECG analyser kit, chest electrodes, clamp electrodes, computer with cardiowin software, conductivity gel.

THEORY:

ECG/EKG- Nomenclature:

Normal EKG tracings consist of waveform components that indicate electrical events during one heart beat. These waveforms are labeled P, Q, R, S, T and U.

P wave is the first deflection and is normally a positive (upward) waveform. It indicates atrial depolarization.

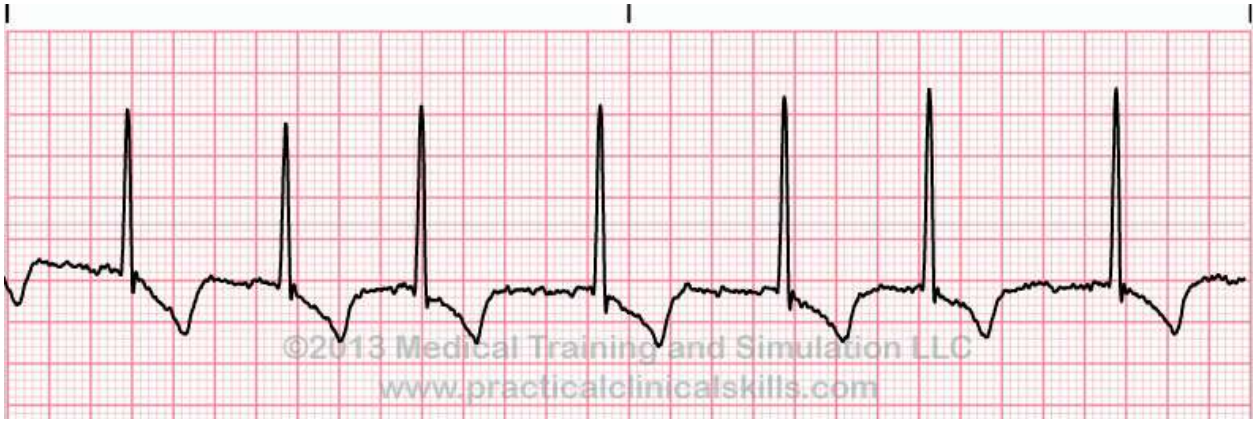
In a normal EKG, the P-wave precedes the QRS complex. It looks like a small bump upwards from the baseline. The amplitude is normally 0.05 to 0.25mV (0.5 to 2.5 small boxes). Normal duration is 0.06-0.11 seconds (1.5 to 2.75 small boxes). The shape of a P-wave is usually smooth and rounded.

QRS complex follows the P wave. It normally begins with a downward deflection, Q; a larger upward deflection, R; and then a downward S wave. The QRS complex represents ventricular depolarization and contraction.

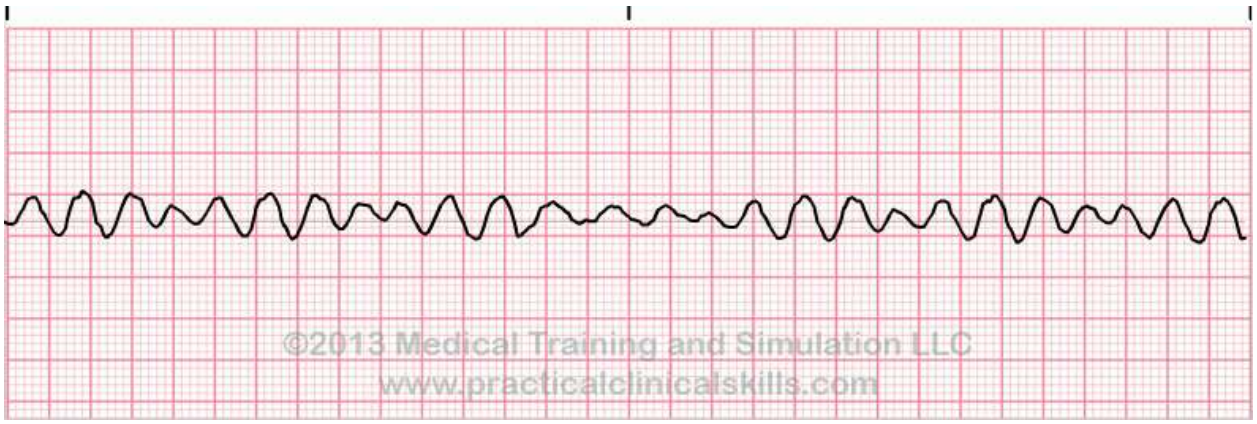
T wave is normally a modest upward waveform, representing ventricular repolarization. It is a slightly asymmetrical waveform that follows (after a pause), the QRS complex. Take note of T waves that have a downward (negative) deflection or of T waves with tall, pointed peaks.

U wave indicates the recovery of the Purkinje conduction fibers. This wave component may not be observable. The U-wave is a small upright, rounded bump. When observed, it follows the T-wave.

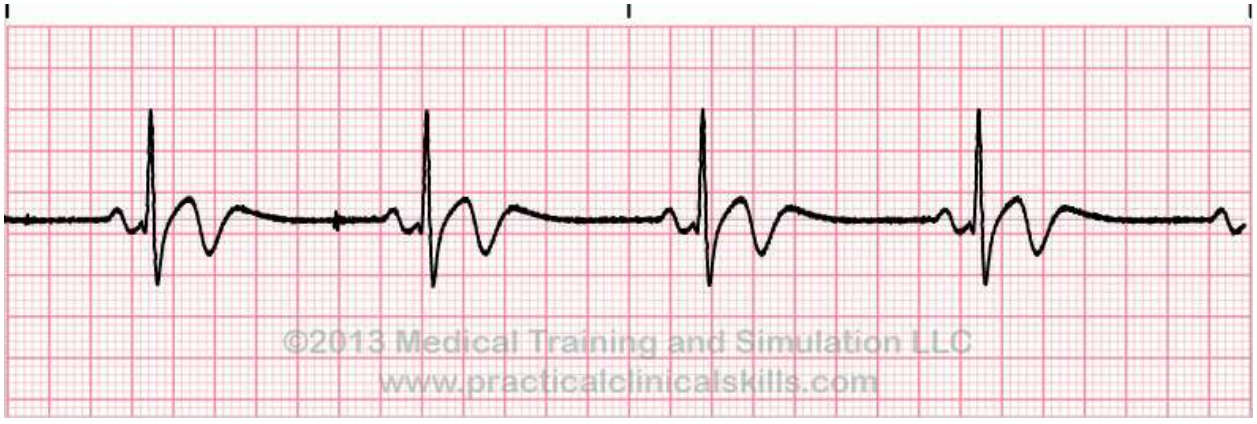
Atrial Fibrillation



Ventricular Fibrillation



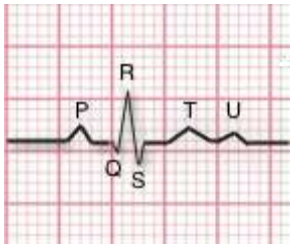
Sinus Bradycardia



ECG Interpretation:

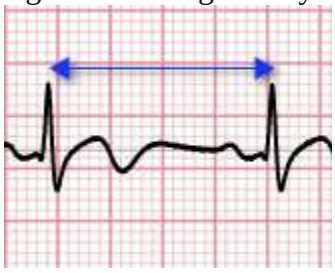
An electrocardiogram or ECG, records electrical activity in the heart. An ECG machine records these electrical signals across multiple heart beats and produces an ECG strip that is interpreted by a healthcare professional.

Normal ECG:



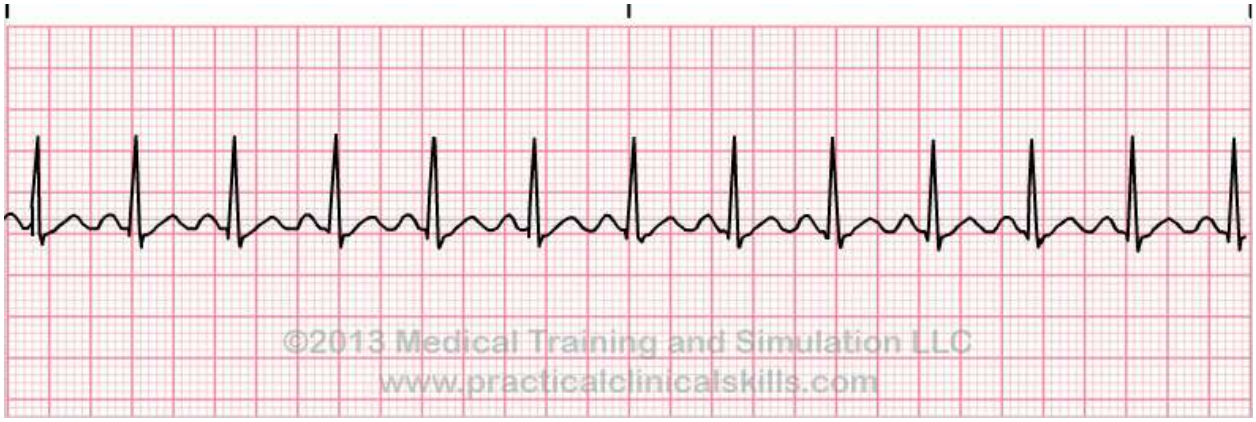
- Pulse rate lies between 60 and 100 beats/minute
- Rhythm is regular except for minor variations with respiration.
- P-R interval is the time required for completion of aerial depolarization; conduction through the AV note, bundle of His, and bundle branches; and arrival at the ventricular myocardial cells. The normal P-R interval is 0 12 to 0.20 seconds.
- The QRS interval represents the time required for ventricular cells to depolarize. The normal duration is 0.06 to 0.10 seconds.
- The Q-T interval is the time required for depolarization and repolarization of the ventricles.

Heart rate:
There are several methods for determining heart rate. Our first method is simple. Count the number of QRS complexes over a 6 second interval. Multiply by 10 to determine heart rate. This method works well for both regular and irregular rhythms. In the first image, we can count 7 QRS complexes, so the heart rate is 70.

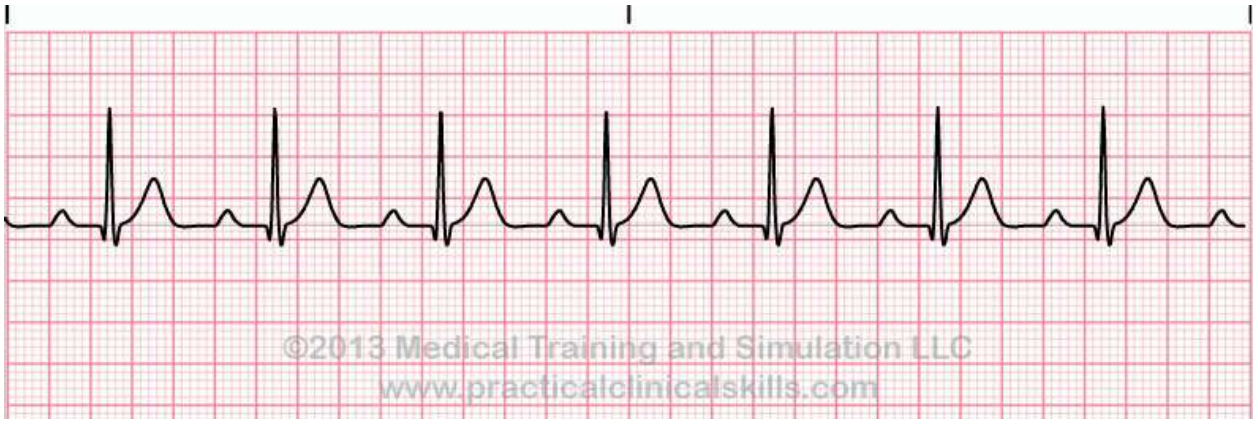


The second method uses small boxes. Count the number of small boxes for a typical R-R interval. Divide this number into 1500 to determine heart rate. In the above shown image, the number of small boxes for the R-R interval is 22.5. The heart rate is 1500/21.5, which is 69.8.

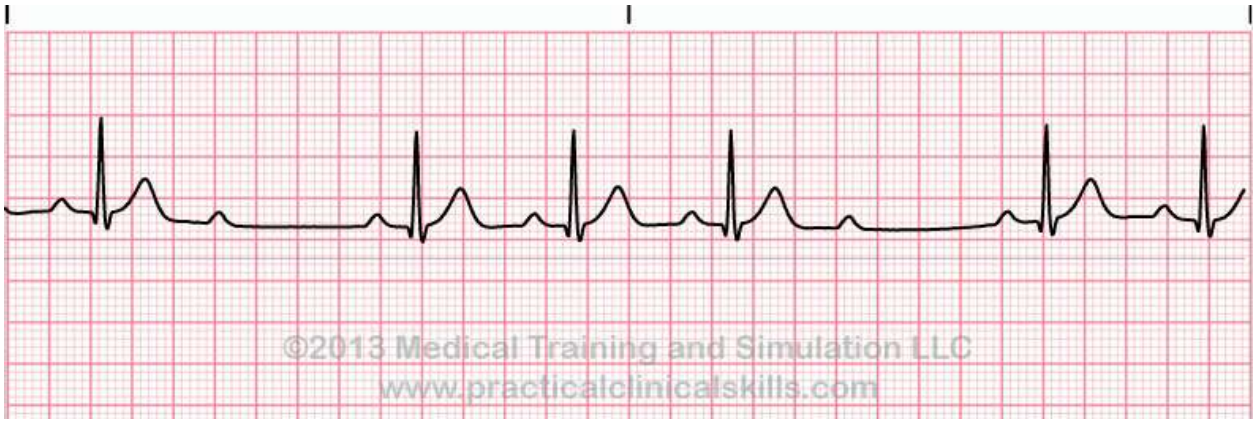
Sinus Tachycardia



First Degree Heart Block



Second Degree Heart Block Type II



ECG Electrodes:

Two arrangements, bipolar and unipolar leads.

Bipolar Lead: One in which the electrical activity at one electrode is compared with that of another. By convention, a positive electrode is one in which the ECG records a positive (upward) deflection when the electrical impulse flows toward it and a negative (downward) deflection when it flows away from it.

Unipolar Lead: One in which the electrical potential at an exploring electrode is compared to a reference point that averages electrical activity, rather than to that of another electrode. This single electrode, termed the *exploring electrode,* is the positive electrode.

Limb Leads: I, II, III, aVR, aVL, aVF explore the electrical activity in the heart in a frontal plane; i.e., the orientation of the heart seen when looking directly at the anterior chest.

Standard Limb Leads: I, II, III; bipolar, form a set of axes 60° apart

Lead I: Composed of negative electrode on the right arm and positive electrode on the left arm.

Lead II: Composed of negative electrode on the right arm and positive electrode on the left leg.

Lead III: Composed of negative electrode on the left arm and positive electrode on the left leg.

Augmented Voltage Leads: aVR, aVL aVF; unipolar ; form a set of axes 60° apart but are rotated 30° from the axes of the standard limb leads.

aVR: Exploring electrode located at the right shoulder.

aVL: Exploring electrode located at the left shoulder.

aVF: Exploring electrode located at the left foot.

Reference Point for Augmented Leads: The opposing standard limb lead; i.e., that standard limb lead whose axis is perpendicular to the particular augmented lead.

Chest Leads: Vl, V2, V3, V4, V5, V6, explore the electrical activity of the heart in the horizontal plane; i.e., as if looking down on a cross section of the body at the level of the heart. These are exploring leads.

Reference Point for Chest Leads: The point obtained by connecting the left arm, right arm, and left leg electrodes together.

Vl: Positioned in the 4th intercostal space just to the right of the sternum.

V2: Positioned in the 4th intercostal space just to the left of the sternum.

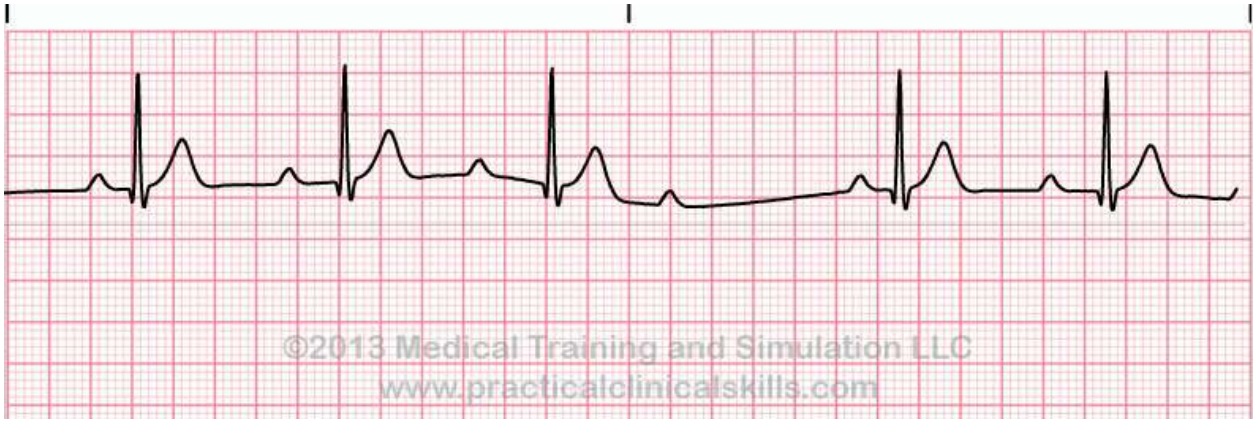
V3: Positioned halfway between V2 and V4.

V4: Positioned at the 5th intercostal space in the mid-clavicular line.

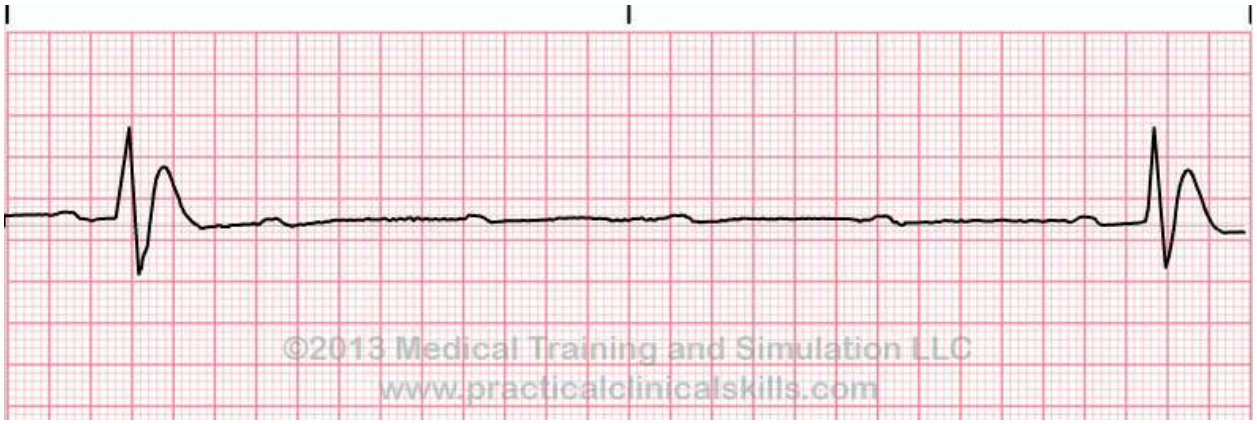
V5: Positioned in the anterior axillary line at the same level as V4.

V6: Positioned in the mid axillary line at the same level as V4 and V5.

Second Degree Heart Block Type I



Third Degree Heart Block



Vl and V2*: Monitor electrical activity of the heart from the anterior aspect, septum, and right ventricle.

V3 and V4*: Monitor electrical activity of the heart from the anterior aspect.

V5 and V6*: Monitor electrical activity of the heart from the left ventricle and lateral aspect.

ABNORMALITIES INTERPRETATION USING ECG

Atrial Fibrillation

Rhythm	Irregular

Rate	Very fast (> 350 bpm) for Atrial, but ventricular rate may be slow, normal or fast
P Wave	Absent - erratic waves are present
PR Interval	Absent
QRS	Normal but may be widened if there are conduction delays

Ventricular Fibrillation

Rhythm	Highly irregular
Rate	Unmeasurable
P Wave	Absent
PR Interval	Not measurable
QRS	None
	EKG tracings is a wavy line

Sinus Bradycardia

Rhythm	Regular
Rate	Slow (< 60 bpm)
P Wave	Normal
PR Interval	Normal (0.12-0.20 sec)
QRS	Normal (0.06-0.10 sec)

Sinus Tachycardia

Rhythm	Regular
Rate	Fast (> 100 bpm)
P Wave	Normal, may merge with T wave at very fast rates
PR Interval	Normal (0.12-0.20 sec)
QRS	Normal (0.06-0.10 sec)

First Degree Heart Block

Rhythm	Regular
Rate	The underlying rate
P Wave	Normal
PR Interval	Prolonged (>0.20 sec)

QRS	Normal (0.06-0.10 sec)
Notes	A first degree AV block occurs when electrical impulses moving through the Atrioventricular (AV) node are delayed (but not blocked). First degree indicates slowed conduction without missed beats.

Second Degree Heart Block Type II

Rhythm	Regular (atrial) and irregular (ventricular)
Rate	Characterized by Atrial rate usually faster than ventricular rate (usually slow)
P Wave	Normal form, but more P waves than QRS complexes
PR Interval	Normal or prolonged
QRS	Normal or wide

Second Degree Heart Block Type I

Rhythm	Irregular but with progressively longer PR interval lengthening
Rate	The underlying rate
P Wave	Normal
PR Interval	Progressively longer until a QRS complex is missed, then cycle repeats
QRS	Normal (0.06-0.10 sec)

Third Degree Heart Block

Rhythm	Regular, but atrial and ventricular rhythms are independent
Rate	Characterized by Atrial rate usually normal and faster than ventricular rate
P Wave	Normal shape and size, may appear within QRS complexes
PR Interval	Absent: the atria and ventricles beat independently.
QRS	Normal, but wide if junctional escape focus

PROCEDURE:

1. Connect the leads appropriately.
2. Obtain the waveform from computer.

3. Find the PQ, QRS complex, ST interval, TU interval.
4. Measure the amplitude of P wave, T wave, ST interval and U wave.

Name of the wave	Amplitude(mV)	Duration (sec)
P wave	0.25	0.12 to 0.22
R wave	1.6	0.07 to 0.1
T wave	0.1 to 0.5	0.05 to 0.15
U wave	<0.1	0.2

DIAGNOSIS:

1. If PQ segment >0.22 Sec – First degree AV block
2. If QRS complex > 0.1 Sec – Bundle block
3. If ST segment is elevated – Myo Cardial fraction
4. If ST segment is depressed – Coronary insufficiency
5. If PQRST waveform is absent and only a train of pulses is present – Ventricul Fibrillation

RESULT:

Thus, study to trace the ECG waveform and measure the various time intervals and amplitude of ECG waveform to make a diagnosis was done.

PULSE RATE MONITOR TRAINER KIT

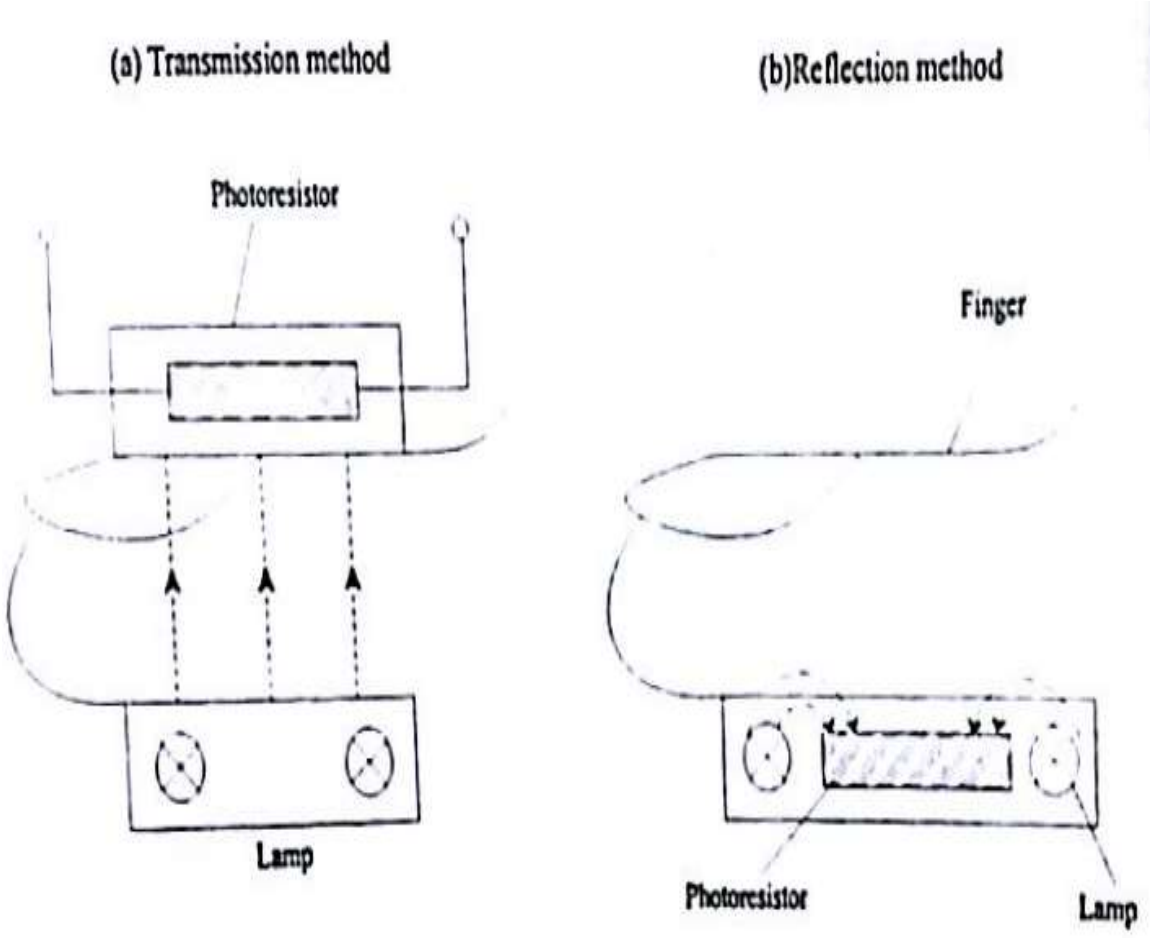


PHOTO ELECTRIC METHODS

11.B. MEASUREMENT AND ANALYSIS OF PULSE RATE

AIM:

To measure the pulse rate.

APPARATUS REQUIRED:

1. VMET-04
2. Photo electric sensor
3. Oscilloscope

TECHNICAL SPECIFICATION:

Sensor type	:	Photo electric sensor		
LED type	:	Ultra-bright LED		
Pulse counter	:	Programmable (micro controller)		
Counting range	:	30-250 beats/min		
Pulse monitor	:	LCD display		
Supply voltage	:	+5V, +12V DC		
Audio generator	:	Buzzer		
Interface connectors	:	Sensor input	:	4 pin DIN connector
		Power	:	3 pin power cord
Weight	:	2.5Kg (approx)		

THEORY:

Measurement of pulse rate:

Each time blood is ejected from the ventricles due to the heart muscles contracts, a pulse of pressure is produced and transmitted through the body circulatory system. This pressure pulse when traveling through the vessel, causes vessel-wall displacement, the finger having vessel which can be used for heart pulse measurement. The pressure pulse is a indicator of blood pressure and flow. The pulse wave travels at 5 to 15m/s, depending on the size and rigidity of artery walls. The velocity of the pulse increases whenever rigidness of artery walls increases. The velocity is 10-15 times faster than the blood flow, and the pulse changes can be determined by the following methods.

i) Electrical impedance changes

ii) Strain-gauge or mechanical

iii) Photo-electric method

1 **Electric Impedance method:** It uses the electrodes to measure the pulse changes (Heart pulse rate). It measure the impedance changes between the electrodes caused by the change in blood volume. The change in impedance may be small as possible in the range of 0.1Ω.

Mechanical method: It involves the use of a strain gauge fitted around a finger with rubber-band. Measurement can be taken, change in resistance of the strain gauge due to the blood volume changes.

Photo-electric: It uses a optical signal which changes resistance of photo transistor due to the change in the blood volume density. The principle advantage of the optical sensor method for medical application is their intrinsic safety since there is no electrical contact between patient and the equipment. They are also less susceptible to Electro-Magnetic Interference.

Photo-electric method:

The photo-electric method uses two methods,

i) Transmittance method

ii) Reflection method

Transmittance method:

In transmittance method, Light Emitting Diode (LED) is placed at one side of the finger and photo transistor in opposite side. Light is transmitted through the finger tip and the resistance of the photo transistor changes due to changes in the amount of light reaching it.

Whenever the heart ejects the blood from ventricle, blood is forced throughout body and the amount of blood in the finger increases. It reduces the light density reaching photo-transistor, which increases photo transistor resistance. The photo transistor connected as part of the voltage divider that produces a voltage which varies with the amount of blood in finger. This pressure pulse is converted to a digital pulse by means of a comparator which used for counting the pulses per minute.

In Reflection method, LED and photo-transistor placed at same side of the finger closely. Part of the light rays emitted by the LED is reflected from the skin due to the blood density variation and fall on photo-transistor. The resistance of photo-transistor changes with respect to blood volume, a pressure pulse created and counted by a digital counter.

Techniques used to calculate heart rate:

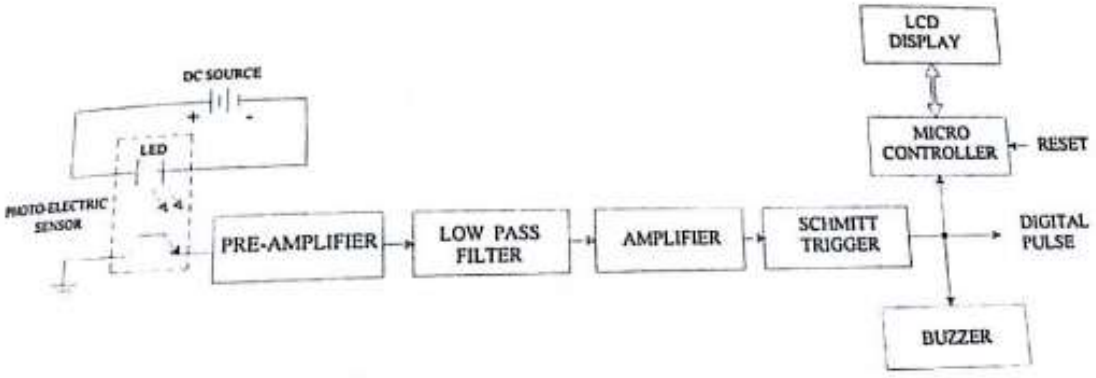
Average calculation:

This is the oldest, but most popular techniques. An average rate (beats/min) is calculated by counting the number of pulses in a given time. The average method of calculation does not show changes in the time between beats and thus it counts only heart beats.

Beat-Beat calculation:
This is done by measuring the time (T), in seconds, between two consecutive pulses, and converting this time into beats/min. This method shows true picture of the heart rate.

Beats=60/T per minute

Pulse Rate System:



PULSE RATE SYSTEM

Photo-electric sensor:
This is the heart of the pulse rate monitoring circuit. The sensor comprises of a low power light emitting diode and a photo-transistor. Considerable amount of light intensity must reach the photo-transistor after passing through finger. So LED must be chosen as a low power and ultra-bright light. The photo-transistor must be sensitive for small light signal variation.

Amplifier and filter:
Signal picked up by photo electric sensor is in range of 'mV' and it could be boosted to some voltage level by means of pre-amplifier. Heart rate frequency range is from 0.8Hz to 5Hz, a filter need to suppress harmonic frequency, 30Hz LPF to do that.

Schmitt Trigger and Counter:
This is a pulse shaping circuit which shapes the pulse signal from the amplifier. Schmitt trigger gives TTL signal to the counter stage. Digital counter is set by micro-controller, measuring range is from 0.06Hz to 5Hz. Liquid Crystal Display (LCD) is used to display pulse rate from 20 to 250 pulses/minute.

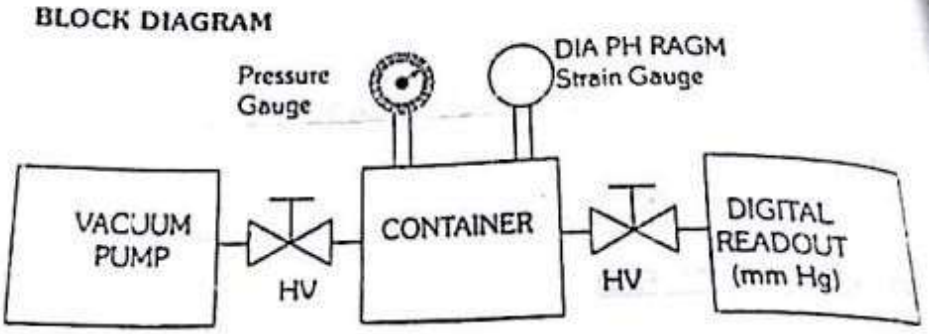
PROCEDURE:

1. Insert a power card into 3-pin AC socket provided backside of the unit, another end to 230V, 50Hz AC mains power supply.
2. Connect the photo electric sensor to bio-signal input socket.
3. Switch ON the power supply to board.
4. Set the buzzer switch in OFF position.
5. Stand the forefinger in between LED and photo transistor in the sensor, wrap the belt attached with the sensor around finger tightly.
6. Connect the test points TP@ one channel. Obtain the blood volume variation waveform channel 1 and corresponding digital pulse in channel 2 of oscilloscope.
7. Press the RESET button micro controller counts pulses for every 30seconds gives pulse rate per minute in average calculation method, the normal pulse rate is 60 to 110 pulses per minute
8. Switch ON the buzzer switch. Hear the pressure pulse sound.

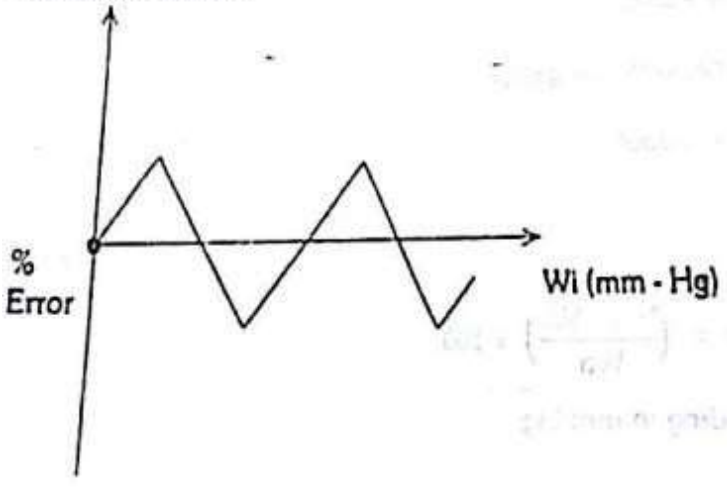
RESULT:

Thus the pulse rate was measured.

BLOCK DIAGRAM



MODEL GRAPH



VACUUM PRESSURE MEASUREMENT

AIM:

To study the given vacuum pressure gauge setup and measure the unknown vacuum pressure.

APPARATUS REQUIRED**:**

Vacuum pump, container with Dial gauge and digital readout.

FORMULA**:**

$$\% \text{ Error} = \frac{(W_a - W_i)}{W_a} \times 100$$

W_a - Actual Pressure in mm Hg
W_i - Indicated Pressure in mmHg

Theory:

The vacuum pressure gauges are used for measurement of pressure below that of atmosphere and this pressure is commonly referred to as vacuum pressure.

Two commonly used units of vacuum measurement are the Torr and Micrometer.

1 Torr = 1mm Hg at standard conditions and
1mm = 10^{-3} Torr

There are two basic methods of vacuum pressure measurement. They are

i) Direct method:

The direct methods of measurement involved measurement of displacement produced by elastic pressure Transducer as a result of application of pressure.

ii) Indirect (or) Inferential method**:**

These methods involve the measurement of pressure through the measurement of certain other properties which depends upon the pressure to be measured and the two important properties are change in volume and change in thermal conductivity.

PROCEDURE:

1 Connect the main chord to the 230 V, 50 Hz AC Mains
2 Connect the vacuum sensor to the indicator with the help of the cable

3 Plug the vacuum pump main chord to supply
4 Connect the section of the nozzle to the vacuum chamber inlet valve by using the given pipe.
5 Switch on the instrument but do not operate the pump Place the READ / CAL switch at READ position and balance the bridge by using Zero knob so that the display should read zero.
6 Close the outlet valve as well as the inlet valve

7 Switch on the vacuum pump and then slowly open the inlet valve
8 Observe the vacuum gauge reading and the digital reading
9 Plot the graph of the indicated reading and percentage error.

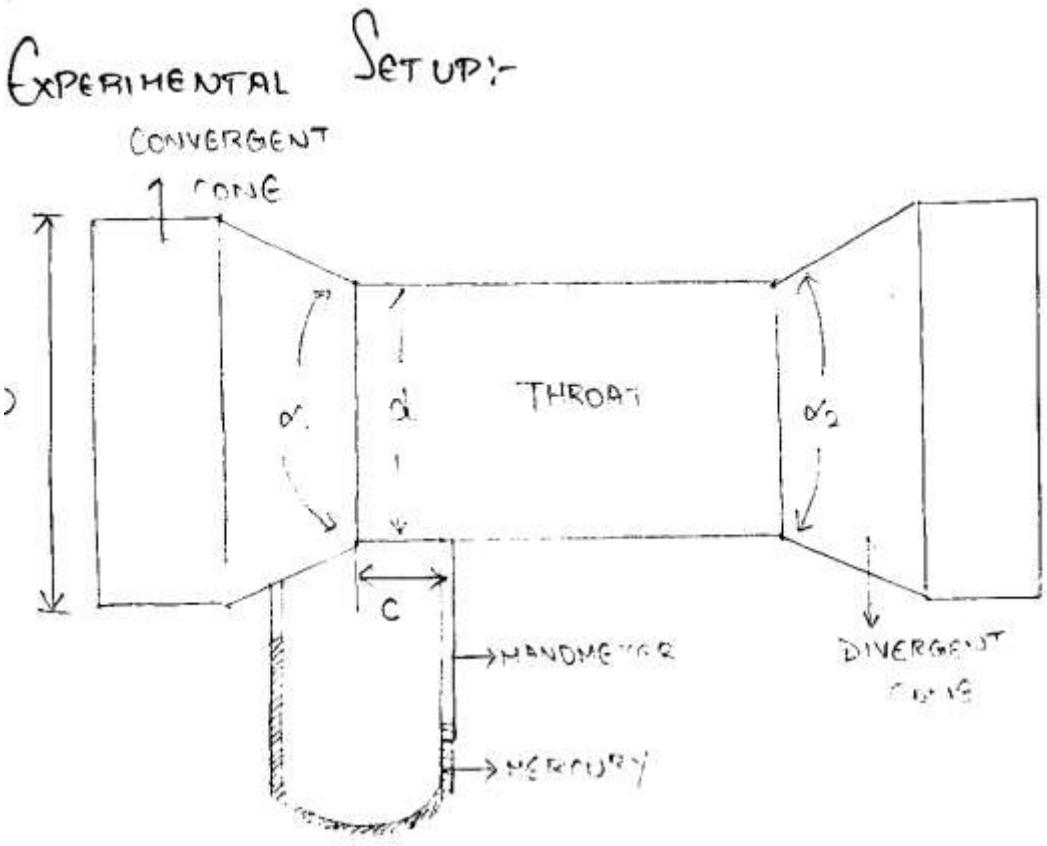
TABULATION:

S.No	Actual Pressure (W_a) mm Hg	Indicated Pressure (W_i) mm Hg	% error

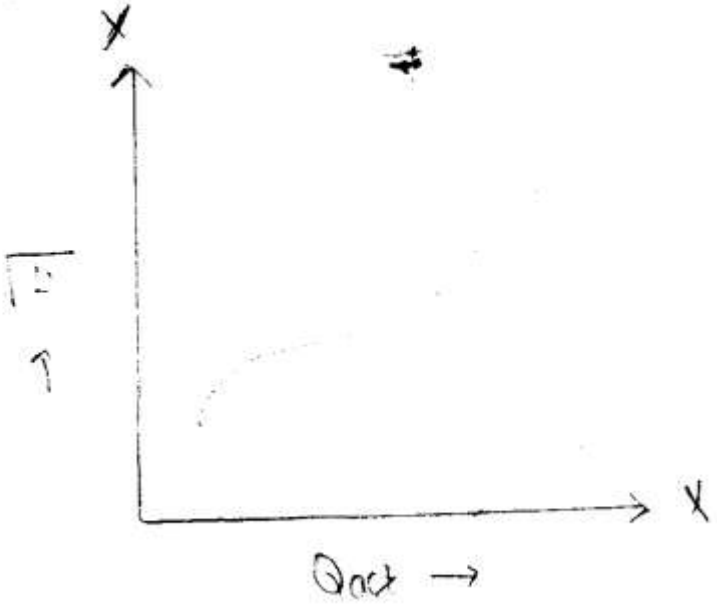
RESULT:

Thus the measurement of vacuum pressure was done using vacuum gauge and the required graph was plotted.

VENTURIMETER EXPERIMENTAL SETUP



MODEL GRAPH:-



VENTURI METER

Ex. No. : 10

Date :

AIM

To determine the co-efficient of discharge of the venturimeter

APPARATUS REQUIRED

1. Venturi Meter
2. Manometer
3. Stop watch
4. Collecting Tank
5. Sump Tank
6. Supply Pump

THEORY

Venturimeter is a device used to measure the rate of discharge of any liquid ing through pipe line. The pressure difference between the pipe section and the at of the venturi meter can be measured from the differential manometer.

$Cd = Q_{act}/Q_{th}$

$Q_{th} = \sqrt{(2.g.H)}.[A_1.A_2 / \sqrt{A_1^2-A_2^2)}]$ m³/sec

$Q_{act} = a.h/t$ m³/sec

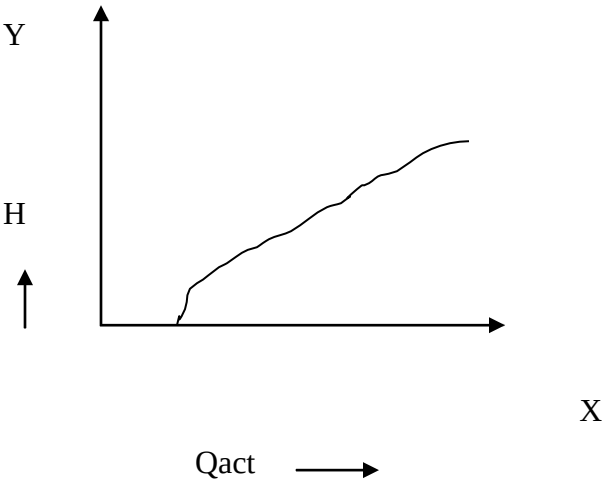
$H = (h_1-h_2) \times \frac{(S_m - S_l)}{S_l}$ m

Cd → Coefficient of discharge

Q_{th} → Theoretical discharge m³/sec

Q_{act} → Actual discharge m³/sec

g → Gravity m/s²



Model Tabulation:

S.No	Rotameter Readings Qact(m3/s)	H1-h2 (mm)	H(m)	Venturi Readings Qth(m3/s)	Coefficient of discharge (Cd)

A_1	→	Area of the pipe	m^2
A_2	→	Area of the throat	m^2
H	→	Differential head of flowing liquid	m
h_1, h_2	→	Manometric heads	m
S_m	→	Specific gravity of manometric liquid	(13.6)
S_1	→	Specific gravity of flowing liquid	(1.00)
a	→	Area of the collecting tank	m^2
h	→	Rise in water level	m
t	→	Time taken (S) for 'h' rise	

PROCEDURE :-

Check wheather all the joints are leakproof and water tight

Close all the cocks on the pressure feed pipes and manometer to prevent damage and overloading of the manometer.

Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.

Switch on the pump to supply the water through the venturimeter.

Open the downstream and upstream cocks which connect the manometer to the venturimeter for which the coefficient of discharge to be calculated

Prime the manometer properly.

Adjust the control valve to maintain the flow steadily and for the desired rate of flow.

Measure the manometric head to find the theoretical discharge.

9. Measure the time taken for 'h' mm rise in the collecting tank to find the actual discharge.

10. Calculate the co-efficient of discharge.

11. Repeat the procedure for the different flow rates.

MODEL CALCULATIONS: (READING NO.)

Diameter of the pipe = mm

Diameter of throat = mm..

Area of the pipe (A_1) = m^2

Area of throat (A_2) = m^2

Area of the collecting tank a = 0.06 m^2

Theoritical discharge

Q_{the} = m^3/s

Actual Discharge

Q_{act} = ah/t

Coefficient of discharge

Cd = Q_{act}/Q_{the}

Cd =

GRAPH :-

The graph for Q_{act} vs H and Q_{act} vs $\sqrt{H}$ were plotted

RESULT

The Coefficient of discharge for the venturimeter is found out and the necessary graph is plotted.

Cd =

VIVA QUESTIONS

FLOW MEASUREMENT

1. Define Flow
2. Define flowrate
3. Define Bernoullis theorem
4. What are the types of flowmeters?
5. List the differential pressure flowmeters
6. Define coefficient of discharge
7. Define Reynold'snumber
8. List variable area flowmeter
9. List inferential type flow meter
10. Define orificeplate
11. State the principle of orificemeter
12. What are the various types of orificemeter
13. Define venacontracta
14. Define d/D ratio
15. State the principle of Rotameter
16. What are the types of rotameter?
17. What are the types of floats?
18. Define buoyancy effect
19. Define specifi cgravity
20. List the units of flow
21. Define Laminar flow.
22. Define Turbulant flow.
23. How flow meters are calibrated?
24. What are the selection criteria for flowmeter?

PRESSURE& LEVEL MEASUREMENT

1. Define pressure
2. Classify pressure ranges
3. Define true pressure
4. Define absolute pressure
5. Define relative pressure
6. Define atmospheric pressure
7. Mention some pressure sensors
8. What is the difference between sensor and transducer?
9. Define 4-20mA.
10. Define differential pressure
11. What is meant by DPT?

12. State the principle of DPT
13. List the direct level measuring methods.
14. List the indirect level measuring methods.

pH & CONDUCTIVITY MEASUREMENT

1. Define pH
2. How pH can be measured?
3. Define pH cell.
4. What are the types of pH electrodes
5. List the measuring electrodes
6. List the standard electrodes
7. Define Nernst equation
8. Define conductivity
9. State the principle of measurement of conductivity
10. What are the types of conductivity measurement?

VISCOSITY MEASUREMENT

1. Define viscosity.
2. What is viscometer?
3. What are Newtonian and non-Newtonian fluids?
4. Define absolute viscosity.
5. Define apparent viscosity.
6. What are the SI units of viscosity?
7. What are the types of viscometer?
8. What is the purpose of Saybolt viscometer?
9. What is the purpose of redwood viscometer?
10. What are the examples for high viscous and low viscous fluids?

ECG MEASUREMENT

1. Expand the term ECG.
2. For which analysis/measurement, ECG is used?
3. What is the normal heart rate?
4. Define systole and diastole.
5. Name the peaks in ECG waveform.
6. Draw a normal PQRST waveform.

VACCUM MEASUREMENT

1. Define vacuum.
2. What are the methods for measurement of low pressure?
3. What is the unit of vacuum?
4. What is Torr?
5. What is the principle of working of thermocouple vacuum gauge?
6. What is the principle of working of ionization type meters?
7. What is the range of pressure that can be measured by ionization type meter?
8. What is the range of pressure that can be measured by pirani gauge?
9. What are the advantages of pirani gauge?
10. What is the principle of working of pirani gauge?

TORQUE MEASUREMENT

1. Define torque.
2. What are the methods used for Torque measurement?
3. What is the unit of torque?
4. What is the relationship between speed and torque?
5. What are slip rings?
6. What is the principle of strain gauge meter?
7. What is the principle of inductive torque transducer?
8. What is the principle of magnetostrictive torque transducer?
9. What are the advantages of digital torque measurement?

SPECTROPHOTOMETER

1. What is the difference between spectrophotometer, spectrometer and colorimetry?
2. List the sources in UV-Visible spectrophotometer
3. List the sources in IR spectrophotometer
4. List the detectors in UV-Visible spectrophotometer
5. List the detectors in IR spectrophotometer
6. What is meant by Photo multiplier tube

DEADWEIGHT TESTER

1. List the parts used in Dead weighttester.
2. How dead weight tester is used as primary calibrating instrument?
3. Difference between accuracy and precision
4. Define range and span
5. Define repeatability and reproducibility