Mission and vision of the Department

Vision of Mechanical Department

To establish the state of the art learning center in Mechanical Engineering which will impart global competence, enterprising skills, professional attitude and human values in the student.

Mission of Mechanical Department

1. To impart quality technical education to the students.
2. To develop comprehensive competence in the students through various modes of learning.
3. To enable students for higher studies and competitive examinations.
4. To facilitate students and industry professionals for continuous improvement and innovation.

Program Educational Objectives:

[1] Use core competence acquired in various areas of Mechanical Engineering to solve techno-managerial issues for creating innovative products that lead to better livelihoods & economy of resources.

[2] To establish themselves as effective collaborators and innovators to address technical, managerial and social challenges.

[3]To equip students for their professional development through lifelong learning and career advancement along with organizational growth.

[4] Serve as a driving force for proactive change in industry, society and nation.

PROGRAM   SPECIFIC OUTCOMES

Student should have

1) An ability to work professionally in mechanical systems including design, analysis, production, measurement and quality control.

2) An ability to work on diverse disciplinary tasks including manufacturing, materials, thermal, automobile, robotics, mechatronics, engineering software tools, automation and computational fluid dynamics.

MAHATMA GANDHI MISSION'S

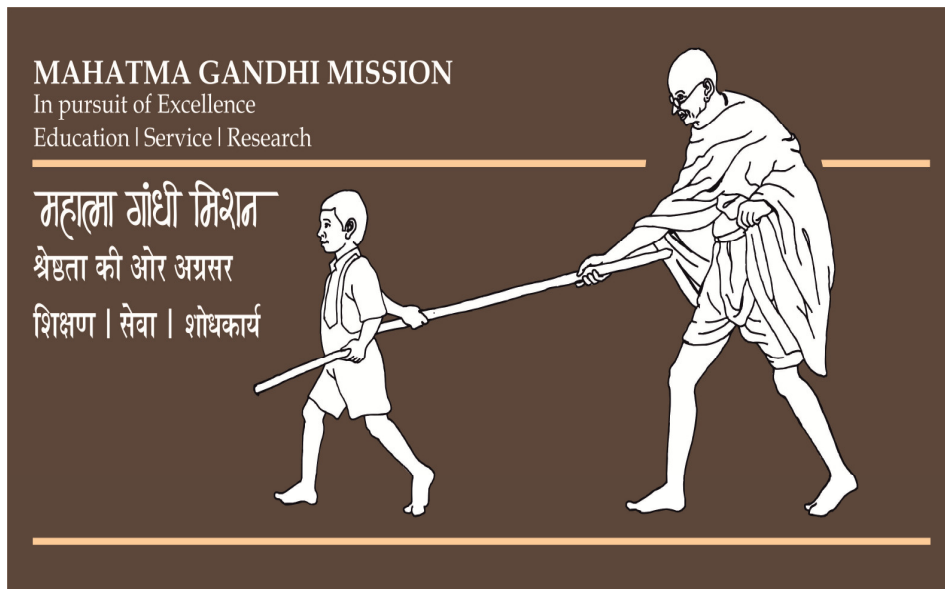# JAWAHARLAL NEHRU ENGINEERING COLLEGE,

AURANGABAD. (M.S.)

DEPARTMENT OF MECHANICAL ENGINEERING

FLUID MECHANICS LABORATORY
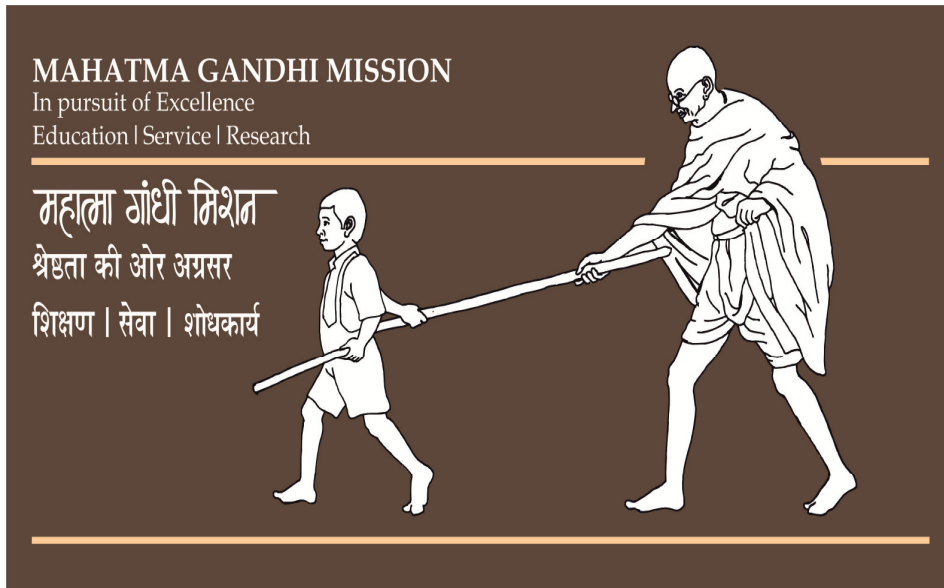
MANUAL

PREPARED BY: - Mr. Kirankumar R. Jagtap

MAHATMA GANDHI MISSION'S

JAWAHARLAL NEHRU ENGINEERING COLLEGE,

AURANGABAD. (M.S.)

DEPARTMENT OF MECHANICAL ENGINEERING

FLUID MECHANICS LABORATORY

MANUAL

Prepared By   **Revised & Approved By**

Mr. Kirankumar R. Jagtap   **Dr.M.S.Kadam**
                                              (Head of Department)

'FLUID MECHANICS' EXPERIMENTS

SUBJECTS: - Fluid Mechanics (T.E.)

LIST OF EXPERIMENTS

Time Allotted for each Practical Session = 02 Hrs.

EXPERIMENT NO: I - to Verify Bernoulli's Theorem

AIM-: To verify the Bernoulli's theorem.

Apparatus-: Bernoulli's Set – Up, Stop Watch, & Meter Scale.

Theory-: Bernoulli's Theorem states that, in a steady, ideal flow of an incompressible flow of fluid, the total energy at any point of the fluid is constant. The total energy consists of **Pressure Energy, Kinetic Energy, & Potential Energy (Datum Energy).** The energy per unit weight of the fluid is Pressure Energy.

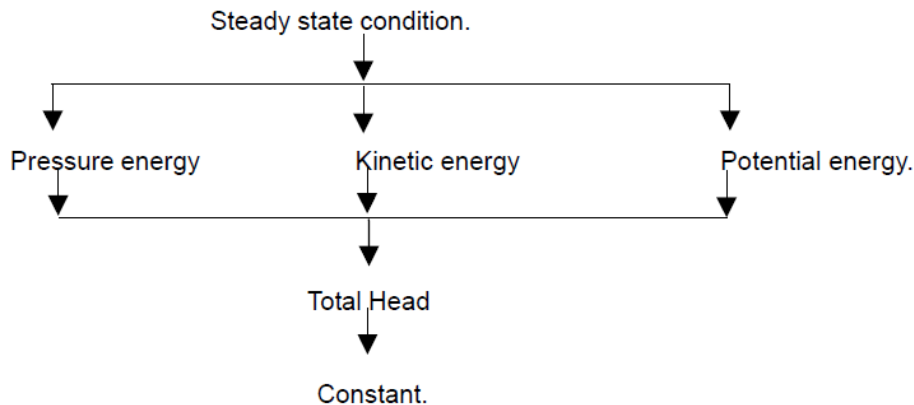Therefore,

Pressure Energy = $P / \rho g$

Kinetic Energy = $V^2 / 2g$ &

Datum Energy   = Z

The **applications of Bernoulli's theorem** are-:

1) **Venturi Meter**
2) **Orifice Meter**
3) **Pitot Tube**

Concept structure:

Description of apparatus labels:

1) BASE FRAME.
2) SUMP TANK.
3) Water PUMP SET
4) Measuring TANK.
5) GATE VALVE.
6) HOSE PIPE.
7) SUPPLY TANK.
8) TRANSPARENT.
9) Delivery TANK.
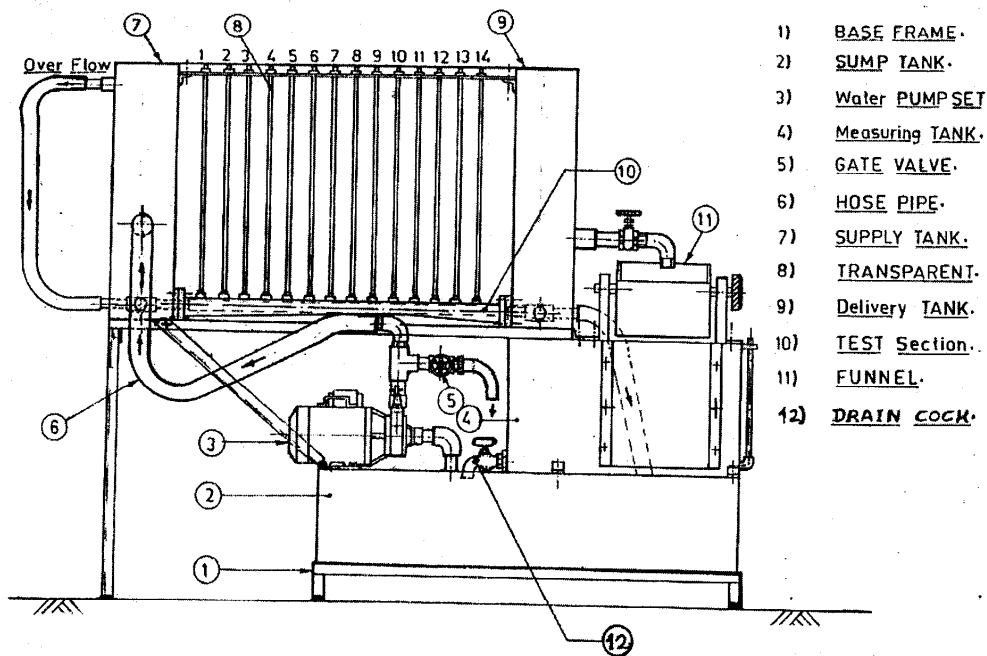10) TEST Section.
11) FUNNEL.
12) DRAIN COCK.

FIG: CLOSE CIRCUIT BERNOULLI'S THEOREM APPARATUS

Description-: The equipment is designed as a self sufficient unit; it has a sump tank, measuring tank, & 0.5 HP monoblock pump for water circulation. The apparatus consists of Supply Tank & Delivery Tank, which are connected to a Perspex flow channel. The channel tapers for a length of 25 cm & then piezo-meter tubes are fixed at a distance of 5 cm , centre – to – centre for measurement of pressure head.

Procedure-:

1. Keep the bypass valve open & start the pump & slowly start closing the valve.
2. The water shall start flowing through the flow channel. The level in the piezometer tubes shall start rising.
3. Open the valve at the delivery tank side, & adjust the head in piezometer tubes to a steady position.
4. Measure the heads at all the points and also discharge with the help of **Diversion Pan** in the measuring tank.
5. Change the discharge & repeat the procedure.
6. Do the necessary calculations using the readings noted down before.

Specifications-:

Tube No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
C/S Area (cm^2)	3.6	3.2	2.8	2.4	2	2.2	2.4	2.6	2.8	3	3.2	3.4	3.6	3.8

Observation Table-:

Table for calculation of total head / Energy.

Piezometer tube no.		1	2	3	4	5	6	7	8	9	10
Run no.1	p/w pressure head										
	V=Q/A(Velocity)										
	$V^2/2g$ (Velocity head)										
	Z(Datum head)										
	p/w+ $V^2/2g$+Z(Total head)										
Run no.2	p/w pressure head										
	V=Q/A(Velocity)										
	$V^2/2g$ (Velocity head)										
	Z(Datum head)										
	p/w+ $V^2/2g$+Z(Total head)										
Run no.3	p/w pressure head										
	V=Q/A(Velocity)										
	$V^2/2g$ (Velocity head)										
	Z(Datum head)										
	p/w+ $V^2/2g$+Z(Total head)										

Results-:

1)For Run No. 01, Discharge (Q_1) is ………..……………m^3/sec;

Total head is ………..meters.

2) For Run No. 01, Discharge (Q_2) is ………..……………m^3/sec;

Total head is ………..meters.

3) For Run No. 01, Discharge (Q_3) is ………..……………m^3/sec;

Total head is ………..meters.

Conclusion: - Practically, the total head doesn't remain constant as Bernoulli claims due to FRICTIONAL LOSSES.

EXPERIMENT NO: II - To Observe Flow Patterns & To Draw Flow Patterns

AIM-: To observe the Flow Patterns and to draw Flow Patterns.

Apparatus-: Flow Visualization Set – Up, Dampers, Cabinet, etc.

Purpose-: This experiments clearly differentiates between Laminar flow and Turbulent Flow.

Theory-:

Laminar Flow-: It is defined as the type of flow in which the fluid particles moves along well defined paths / streamlines and all the streamlines are straight & parallel.

Turbulent Flow-: It is the type of flow in which the particles move in zigzag way. The eddies formation takes place which are responsible for high energy loss.

When fluid is flowing, its flow is in the form of lamina, sliding over each other. When certain obstacles are immersed in the flow, the flow is disturbed, but still the lamina remains separate. When the velocity of flow exceeds certain limit, the laminas no longer remain separate. But they diffuse over each other & flow becomes Turbulent. The apparatus is designed to visualize this phenomenon & to observe the flow patterns around the obstacles of various shapes.
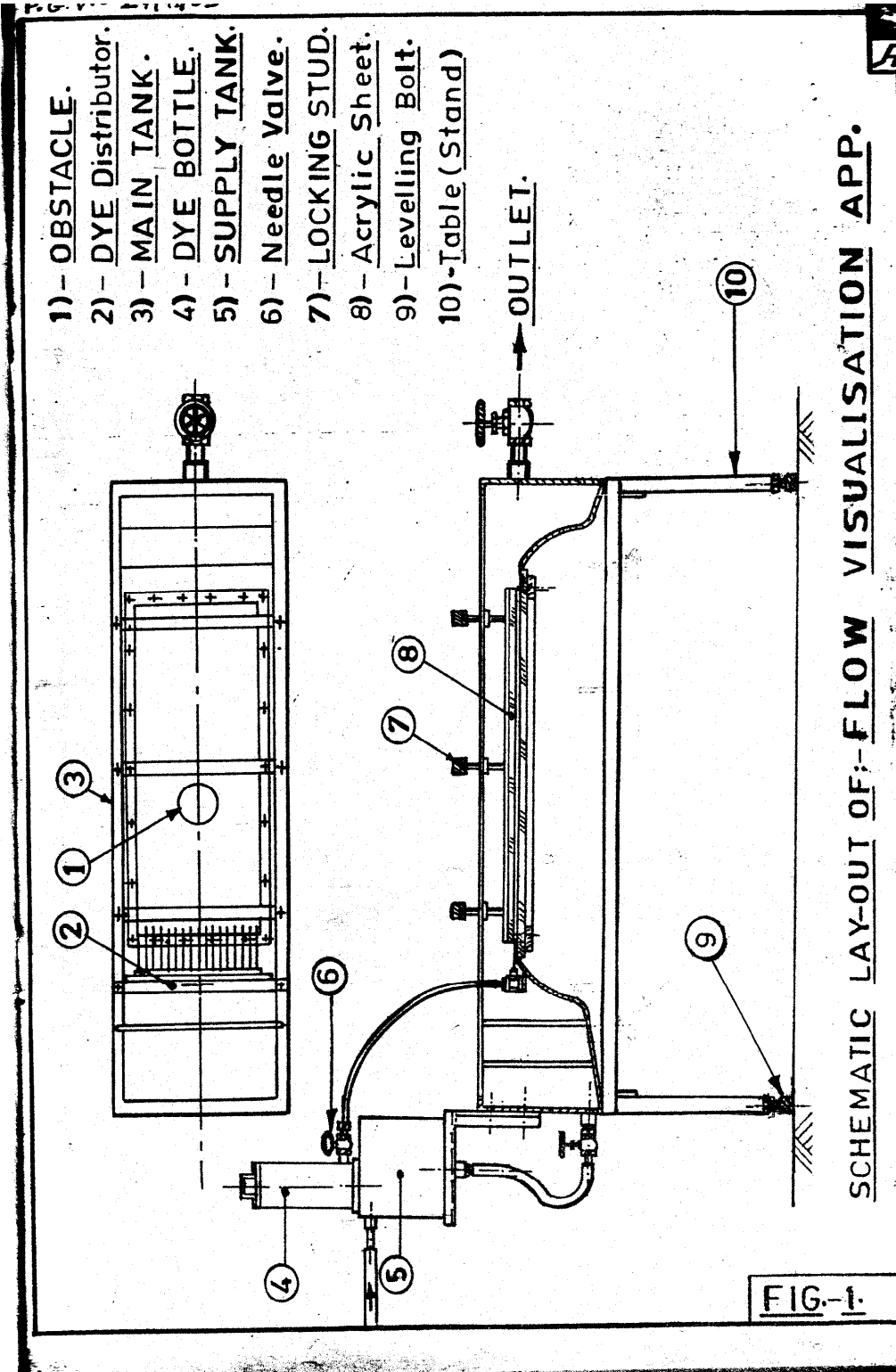
Procedure-:

The apparatus is made up of Perspex sheet. These sheets are suitably arranged in a horizontal casing. Water is supplied at one end of the casing, and it is allowed to flow between the sheets. Dye bottle is fixed over a stand provided on casing. Dye is prepared from colored solution, like solution of **Potassium Permanganate.**

Dye enters the Dye manifold & then into the main flow through the small tube. Obstacles of various shapes can be kept between the sheets. The casing is provided with leveling bolts so that the apparatus can easily leveled with slight downward inclination towards outlet of water. A cabinet is at the core.

Initially, the flow of water is maintained very slow & dye is allowed to flow with water through the obstacles. As the water flow speed is very slow, we can observe the Laminar flow clearly in which laminas remains separate.

And then, the flow of water is increased & dye is allowed to flow with water through the obstacles. As the water flow speed is more, we can observe the Turbulent flow clearly in which laminas do not remains separate, they mix with each other.

Result-: We have studied the various types of flow patterns.

1) – OBSTACLE.
2) – DYE Distributor.
3) – MAIN TANK.
4) – DYE BOTTLE.
5) – SUPPLY TANK.
6) – Needle Valve.
7) – LOCKING STUD.
8) – Acrylic Sheet.
9) – Levelling Bolt.
10) – Table (Stand)

OUTLET.

SCHEMATIC LAY-OUT OF:- FLOW VISUALISATION APP.

FIG.-1.

EXPERIMENT NO: III - To Determine the Metacentric Height of a Cargo / War Ship

AIM: - To Determine the Metacentric Height of a Cargo / War Ship

INTRODUCTION:-

Metacenter is defined as, the point about which the body starts oscillating when it is tilted (inclined) by a small angle.

Metacenter may also be defined as, the point at which the line of action of force of buoyancy will meet the normal axis of the body when the body is given a small angular displacement.

Metacentric Height is defined as, the distance between the Metacenter of a floating body & center of gravity.

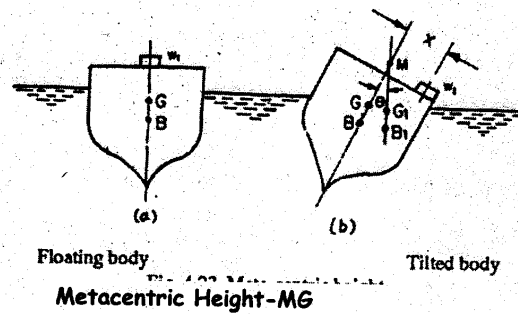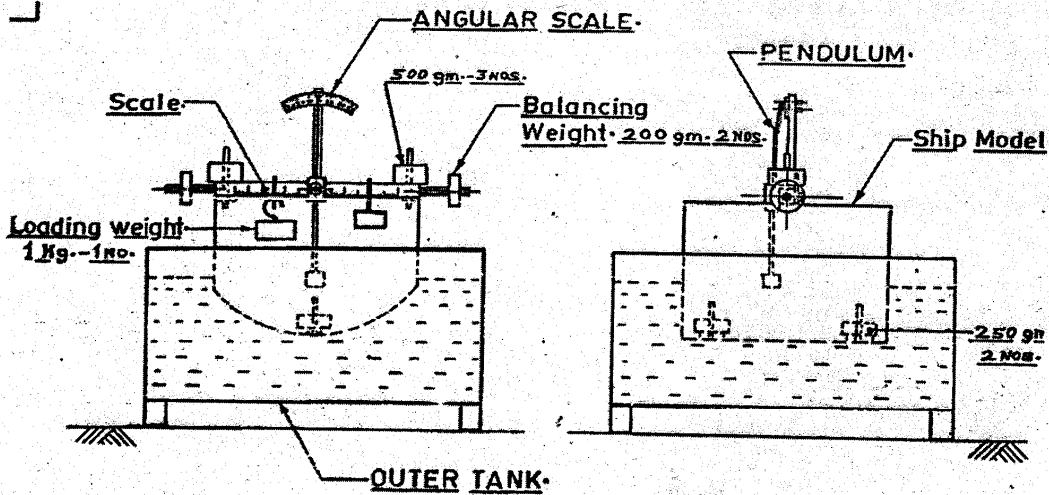Figure-1

Metacentric Height-MG

Figure-2

SCHEMATIC LAY-OUT OF METACENTRIC HEIGHT OF A SHIP.

DESCRIPTION:-

The ship model is approximately 37 cm size square in plan and is about 23 cm high. The model is floated on water. The ship is tilted by moving a small weight at the level of the deck of the ship. To note down the tilt of the ship, a plumb is provided which records the tilt on a graduated arc of a circle. An arrangement is made to load the ship as a War ship or Cargo ship.

PROCEDURE:-

Sr. No.	For Cargo Ship	For War Ship
1	Place suitable symmetrical weights **at the bottom of the ship** and load it as a Cargo Ship.	Place suitable symmetrical weights **at the deck level of the ship** and load it as a War Ship.
2	Float the ship on the water.	Float the ship on the water.
3	Adjust the balancing weights on both the sides of the ship so that the Plumb indicates zero reading on the graduated arc.	Adjust the balancing weights on both the sides of the ship so that the Plumb indicates zero reading on the graduated arc.
4	Keep the Moving (Hanging) Load/Weight at a distance of 4 cm off the centre on left side.	Keep the Moving (Hanging) Load/Weight at a distance of 4 cm off the centre on left side.
5	Note down the tilt of the ship in degrees.	Note down the tilt of the ship in degrees.
6	Go on shifting the Hanging Load towards left & note down the distance of the centre, & tilt of the ship.	Go on shifting the Hanging Load towards left & note down the distance of the centre, & tilt of the ship.
7	Repeat the procedure by shifting the load on the right hand side of the centre.	Repeat the procedure by shifting the load on the right hand side of the centre.

OBSERVATION TABLE:-

W_1 = Weight of the ship including balancing weight in grams

    = 6200 GMS + 500GMS = **6700 GMS**

W_2 = Total weight added to make it as a Cargo / War Ship = 02 X 500 GMS = 1000 GMS

W_3 = Weight of the Hanging Load in grams = 02 X 250 GMS = 500 GMS.

W = W1 + W2 = 6700 + 1000 = **7700 GMS**.

Obs. Table FOR CARGO SHIP

(Prepare Same table table for **WAR SHIP** & do calculations)

Sr. No.	Distance off the centre to the left 'X' in cms	Tilt of the Ship 'θ' in degrees	Metacentric Height=MG_1 in cms.	Distance off the centre to the left 'X' in cms	Tilt of the Ship 'θ' in degrees	Metacentric Height=MG_2 in cms	Average MG in cms
01							
02							
03							
04							

SPECIMEN CALCULATIONS:-

$W = (w_1 + w_2)$ in grams.

MG_1 or MG_2 = Metacentric Heights in centimeters.

        = W_1 x **X** / W x **tan θ⁰**

Average MG = MG_1 + MG_2 / 2

RESULTS:-

- Metacentric Height of a **Cargo Ship (MG c)** = …………..cms.
- Metacentric Height of a **War Ship (MGw)** = …………..cms.

CONCLUSION:-

As the angle of tilt (θ⁰) increases, Metacentric Height (MG or GM)

……………increases / **decreases**.

EXPERIMENT NO: IV – MEASUREMENT OF FLOW THROUGH VENTURIMETER & ORIFICEMETER

AIM:-
To find out Cd (Coefficient of Discharge) of given Venturimeter and Orificemeter.

A) VENTURIMETER APPARATUS
   (Recirculation Type)

DESCRIPTION :

      This equipment is designed as Re-circulation type set-up with a standard Venturimeter fitted in a pipeline. A Sump Tank is provided on which the Measuring Tank, Monoblock pump & piping assembly with Venturimeter are fitted, making the system recirculation set-up. A Venturimeter of d/D ratio 0.5 – 1" dia is provided in the line. Connections of pressure tapings are given to the differential manometer. Control valve is provided to vary the flow rate of the discharge.

SPECIFICATIONS OF VENTURIMETER:
1. Venturimeter :   d/D ratio 0.5. Made up of acrylic.
2. Sump Tank :   Size : 900mm. x 400mm. x 450mm ht.
          Material -   M.S. Sheet - 18 gauge with F.R.P.
          coating from inside.
3. Measuring Tank :   Size -   400mm. x 300mm. x 300mm. ht.
          Material -   M.S. Sheet – 18 gauge with F.R.P.
          coating from inside. Piezometric Tube with scale.
4. Monoblock Pump : Capacity -   0.5 HP, Single Phase, 230 V.
          with required bye-pass valve and suction piping
          for connecting the basic unit to the Sump Tank.
          Crompton Greaves Make.
5.   Control valve for controlling the flow rate.
6.   Differential Tube Acrylic Manometer (**With Mercury**) having distribution blocks fitted on a board.

PROCEDURE:
1.   Fill the Sump tank with clean water (preferably non salty) up to 3/4th level of the tank. Ensure that bye-pass control valve is fully open.
2.   Before starting the unit first time Or after a long period follow the given steps…
a)   Open the back cover of the Mono-block Pump.
b)   Ensure if the fan shaft is rotating freely. If not then make it free by rotating the shaft till it becomes free.
c)   After making the shaft free then fix the back cover.
3.   Keep the bye-pass valve, the downstream valve of the pipe line open.
4.   Now switch on the Pump. If discharge is not there then stop the pump and prime the pump by opening the overflow valve of the pump (Brass valve on the pump).
5.   Close the bye-pass valve slowly after water starts flowing through the piping to adjust suitable discharge.
6.   Take readings of the manometer connected after closing the tapings.
7.   Also measure discharge in the measuring tank.
8.   Change the discharge and take same more readings.

OBSERVATIONS

D1 = Dia of inlet of Venturimeter   = 26mm.

D2 = Dia. Of throat of Venturimeter = 13mm.

* S   = Specific gravity of manometric fluid = (mercury) 13.6

OBSERVATION TABLE

Sr.No	' Hg' in mm. (Difference)	Hwater in mtrs. = Hg(S-1)/100	Time in secs for 5 cm rise 'T'	Qact in m³/sec.	Qth in m³/sec	K or Cd.

SPECIMEN CALCULATIONS**:**

$$Qa = \frac{\text{Tank Area x z}}{T} = \frac{0.4 \times 0.3 \times z}{T} \ \text{m}^3/\text{sec}$$

Where   T = time in seconds required for 5 cm height.

z = Ht. of water column = 5cm = 0.05mtr.

$$a1 = \frac{\pi}{4} d_1^2 \ \text{in m}^2 = \frac{\pi}{4} \times (0.026)^2 = 5.32 \times 10^{-4} \ \text{m}^2$$

$$a2 = \frac{\pi}{4} d_2^2 \ \text{in m}^2. = \frac{\pi}{4} \times (0.013)^2 = 1.32 \times 10^{-4} \ \text{m}^2$$

$$Qt = \frac{a1 \cdot a2}{\sqrt{a^2 1 - a^2 2}} \ \sqrt{2 \ gh}$$

Where

$d_1 =$ Dia. of inlet of the Venturi meter   =   26mm.

$d_2 =$ Dia. of throat of the Venturi meter.   =   13 mm

Qa=   actual discharge. = m³/sec

$a_1 =$ area at inlet of the Venturi meter $= m^2$.

$a_2 =$ area at throat of the Venturi meter $= m^2$.

$Q_t =$ theoretical discharge $= m^3/sec$.

$g = 9.81 \ m/sec^2$

$h =$ Mano. reading in mtrs. X $(13.6 - 1) =$

$$C = \frac{a_1 \cdot a_2}{a\sqrt{1 - a^2 2}} \sqrt{2 g} \quad = \ \textbf{6.05 x 10}^{\textbf{-4}} \quad \textbf{(For Venturimeter)}$$

$Q_t = C \ x \ \sqrt{h}$

Where $g = 9.81 \ m/sec^2$

$* \ h = h' \ (13.6 - 1) = 12.6 \ h' \ / \ 100 = \quad m$

$$K \ or \ C_d = \frac{Qa}{Qt}$$

Where Qa   =   actual discharge.
   a_1 =   area at inlet of the Venturimeter.
   a_2 =   area at throat of the Venturimeter.
   Qt   =   theoretical discharge.

Specimen Readings & Sample of Calculations **:**

1. FOR VENTURIMETER

Sr. No	LPH Rota meter flow rate	Manometer readings h in cms of water	'h' in mtrs of Hg.	'X' Ht. of $H2O$ collected	t in sec.	Qa in m^3/sec.	Qt in m^3/sec	K or Cd.
01	2500	15.2– 10 = 5.2	0.052 x 12.6	5 cm =0.05mts.	12.5	6×10^{-4}	6.48×10^{-4}	0.92
02	2050	14.5 –11 = 3.5	0.035 x 12.6	5 cm =0.05mts	14.4	5.2×10^{-4}	5.32×10^{-4}	0.97

SPECIMEN CALCULATIONS **:**

$$Qa = \frac{\text{Lt. of Tank x Bd. of Tank x Ht. of water collected in Tank (i.e. X = 5 cm)}}{\text{' t ' time required for collecting 5 cm Ht. of water in the Tank.}}$$

$$Qt = \frac{a1 . a2}{\sqrt{a^2 1 - a^2 2}} \sqrt{2 gh}$$

Where

d_1 = Dia. of inlet of the Venturi meter = 28mm.

d_2 = Dia. of throat of the Venturi meter. = 14 mm

Qa= actual discharge. = m^3/sec

a1= area at inlet of the Venturi meter = m^2.

a2 = area at throat of the Venturi meter = m^2.

Qt = theoretical discharge = m^3/sec.

g = 9.81 m/sec^2

h = Mano. reading in mtrs. x (13.6 – 1) =

$$a1 = \frac{\pi}{4} d^2 1 \text{ in sq.m.}$$

a1 = $0.785 \times (0.030)^2 = 7.06 \times 10^{-4} m^2$

Page16

$$a_2 = \frac{\pi}{4} d_2^2 \text{ in sq.m.}$$

$$a_2 = 0.785 \times (0.015)^2 = 1.76 \times 10^{-4} \text{ m}^2$$

$$\text{K or } C_d = \frac{Qa}{Qt}$$

Now,

$$Qa = \frac{0.5 \text{ (m) } \times 0.3 \text{(m) } \times 0.05 \text{(m)}}{12.5 \text{ (Sec)}} = 6 \times 10^{-4} \text{ m}^3/\text{sec.}$$

For calculation of 'Qt' follow as given below

$$a_1 \times a_2 = 7.06 \times 10^{-4} \times 1.76 \times 10^{-4} = 1.243 \times 10^{-7} \text{ m}^2$$
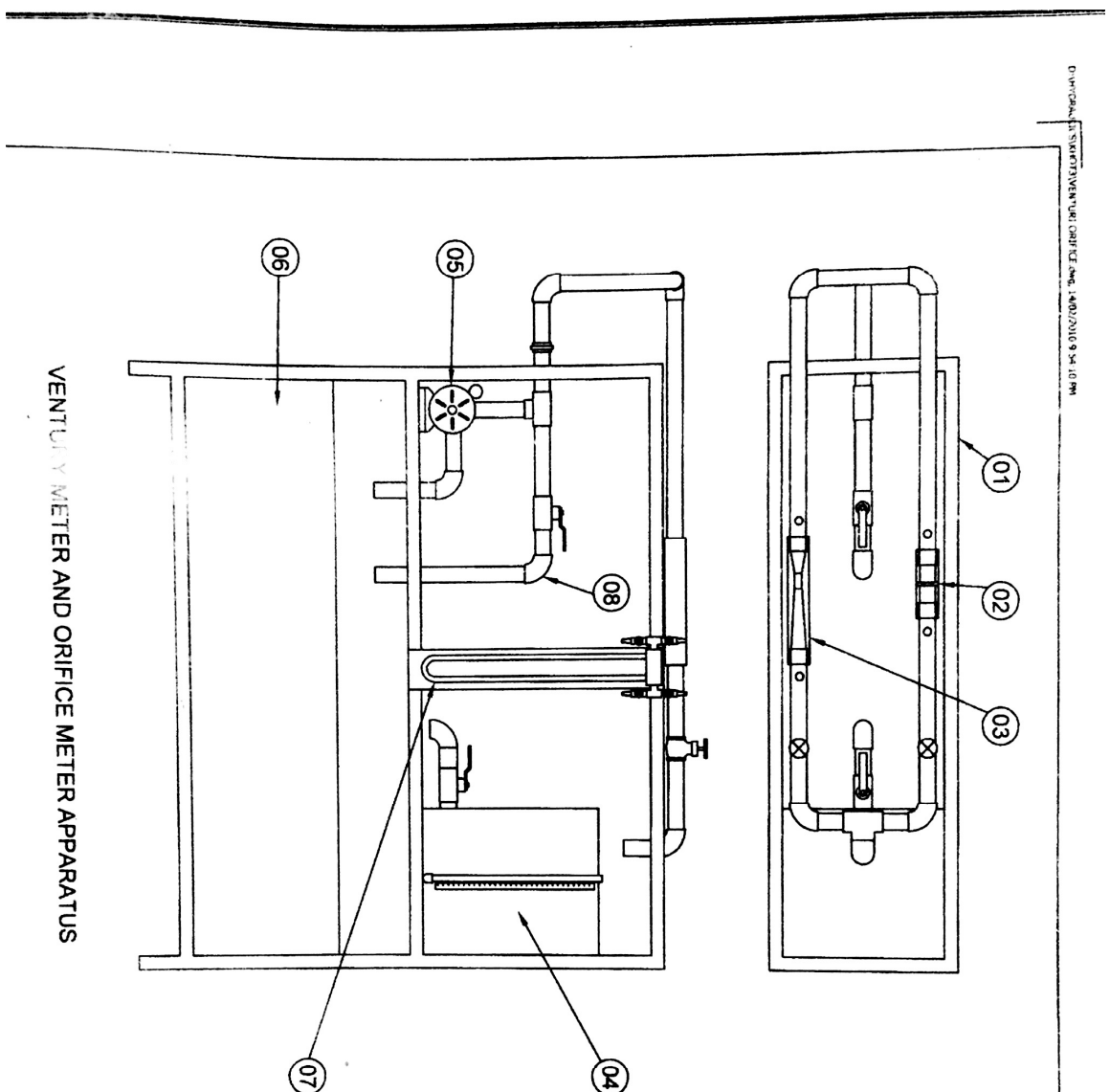
$$\sqrt{a_1^2 - a_2^2} = \sqrt{(7.06 \times 10^{-4})^2 - (1.76 \times 10^{-4})^2}$$

$$= \sqrt{4.68 \times 10^{-7}} = 6.84 \times 10^{-4} \text{ m}^2$$

$$\therefore Qt = \frac{1.243 \times 10^{-7}}{6.84 \times 10^{-4}} \times \sqrt{2 \times 9.81 \times 0.052 \times 12.6}$$

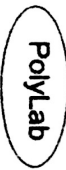$$= 1.81 \times 10^{-4} \times 3.585 = 6.488 \times 10^{-4} \text{ m}^3/\text{sec.}$$

$$C_d = \frac{Qa}{Qt} = \frac{6 \times 10^{-4}}{6.488 \times 10^{-4}} = 0.92$$

═══════════

MGM'S JNEC, AURANGABAD, MECHANICAL ENGINEERING DEPT.

VENTURY METER AND ORIFICE METER APPARATUS

01 MAIN FRAME

02 ORIFICE

03 VENTURY

04 MEASURING TANK

05 PUMP MOTOR

06 SUMP TANK

07 MANOMETER

08 BYPASS

PolyLab

PolyLab Engineering Equipment
Mirai

B) <u>ORIFICEMETER APPARATUS</u>
(Recirculation Type)

<u>DESCRIPTION</u>

This equipment is designed as Re-circulation type set-up with a standard orifice meter fitted in a pipeline. A Sump Tank, Measuring Tank, pump & piping is provided as a basic set-up. Orificemeter of d/D ratio of 0.5 is provided in the line. Connections of pressure tapping are given to the differential manometer.

<u>SPECIFICATIONS FOR ORIFICEMETER</u>

1. Orificemeter   :   d/D ratio 0.5 Made up of acrylic
                                  Inlet Dia.   -   26mm.
                                  Throat Dia. - 13mm.

4. Sump Tank   :   900 x 400 x 400 mm.
                                  Material - M.S. Sheet - 18 gauge with F.R.P.
                                                 coating from inside.

5. Measuring Tank   :   Size   -   400 x 300 x 300mm.
                                  Material - M.S. Sheet – 18 gauge with F.R.P.
                                                 coating from inside.
                         Piezometric Tube with scale for flow measurement.

5. Monoblock Pump   :   Capacity - 0.5 HP, Single Phase, 230 V.
                                  with required bye-pass valve and suction piping.
                                  Flexible Hose Pipe for connecting the basic unit to
                                  the Sump Tank. "Kirloskar Make"

7. Control valve for controlling the flow rate.

8. Stop Watch.

9. 'U' Tube Manometer with Mercury – Acrylic type.

PROCEDURE

9. Keep the bye-pass valve open and start the pump. Keep the downstream valve of the pipe line open

10. Close the bye-pass valve after water starts flowing through the piping to adjust suitable discharge.

11. Take readings of the manometer connected after closing the tapings,

12. Also measure discharge in the measuring tank.

13. Change the discharge and take same more readings.

OBSERVATION TABLE

Sr.No	' Hg' in mm. (Difference)	Hwater in mtrs. = Hg(S-1)/100	Time in secs for 5 cm rise 'T'	Qact in m^3/sec.	Qth in m^3/sec	K or Cd.

OBSERVATIONS

d_1 = Inlet Dia of Orificemeter = 26mm

d_2 = dia. Of throat of Orificemeter = 13mm

* S = Specific gravity of manometric fluid (Mercury) = 13.6

CALCULATIONS :

$$Qa = \frac{Tank\ Area \times z}{T} = \frac{0.4 \times 0.3 \times z}{T}$$

$$a_1 = \frac{\pi}{4}\ d^2{}_1\ in\ m^2. = \frac{\pi}{4} \times (0.026)^2 = 5.32 \times 10^{-4}\ m^2$$

$$a_2 = \frac{\pi}{4}\ d^2{}_2\ in\ m^2. = \frac{\pi}{4} \times (0.013)^2 = 1.32 \times 10^{-4}\ m^2$$

$$Qt = \frac{a_1 \cdot a_2}{\sqrt{a^2{}_1 - a^2{}_2}}\ \sqrt{2\ gh}$$

C = 5.89 x 10^{-4}   **(For Orifice meter)**

$$Qt = C \times \sqrt{h}$$

Where g = 9.81 m/sec^2

* h = h' (13.6 – 1) = 12.6 h' / 100 = m

$$K \text{ or } C_d = \frac{Qa}{Qt}$$

Where Qa   =   actual discharge.

a1   =   area at inlet of the Orificemeter. = ------- x 10^{-4} m^2

a2   =   area at throat of the Orificemeter = ------- x 10^{-4} m^2

Qt   =   theoretical discharge.

EXPERIMENT NO: V –

# TO IDENTIFY THE TYPE OF FLOW BY USING REYNOLDS' APPARATUS.

REYNOLD'S NUMBER:

Reynolds number 'Re' is the ratio of inertia force to the viscous force where viscous force Is the product of shear stress and area inertia force is the product of mass and acceleration.

APPARATUS:

1. Reynolds's apparatus which consists glass tube, water tank and a small dye container at the top of tank.
2. Potassium permanganate (dye).
3. Measuring tank.
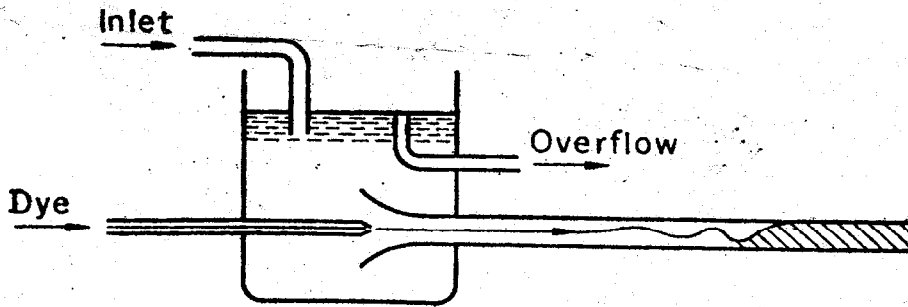4. Stop watch.

DIAGRAM:
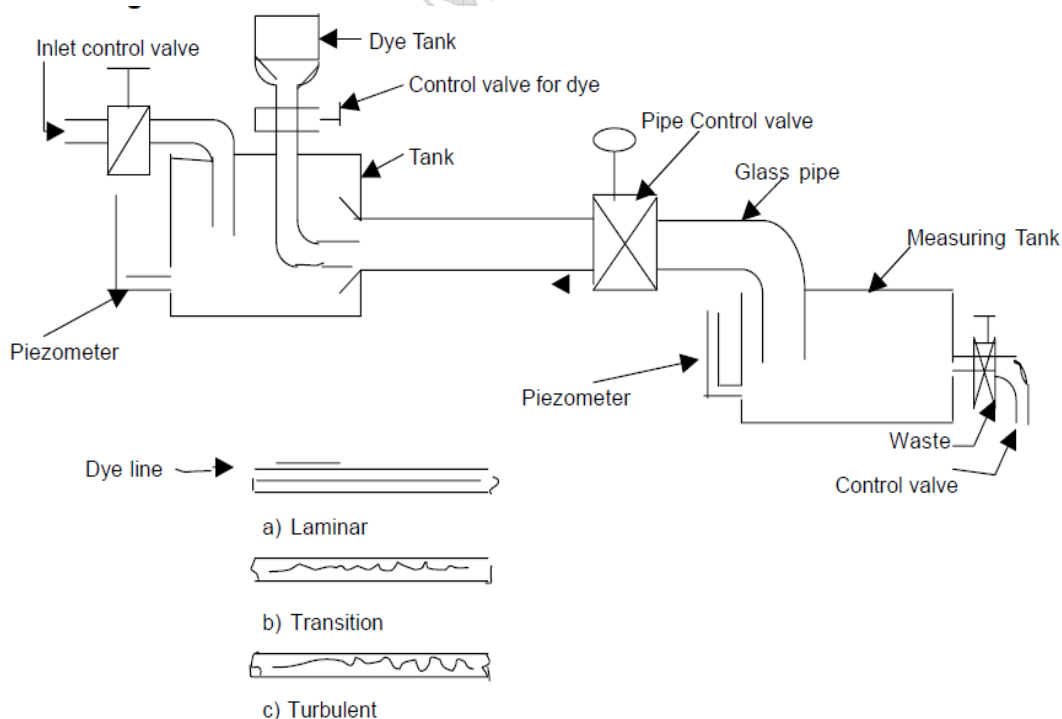
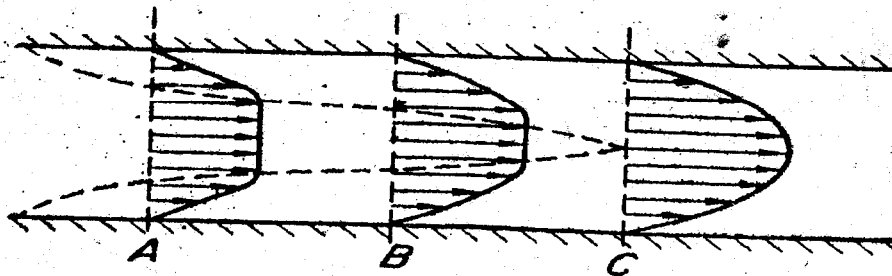FIG1: Reynolds' Experiment. The mixing of the dye indicates that flow is turbulent
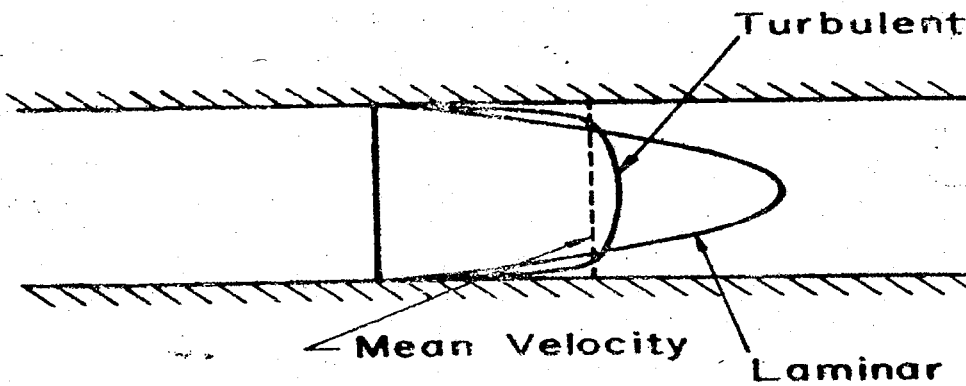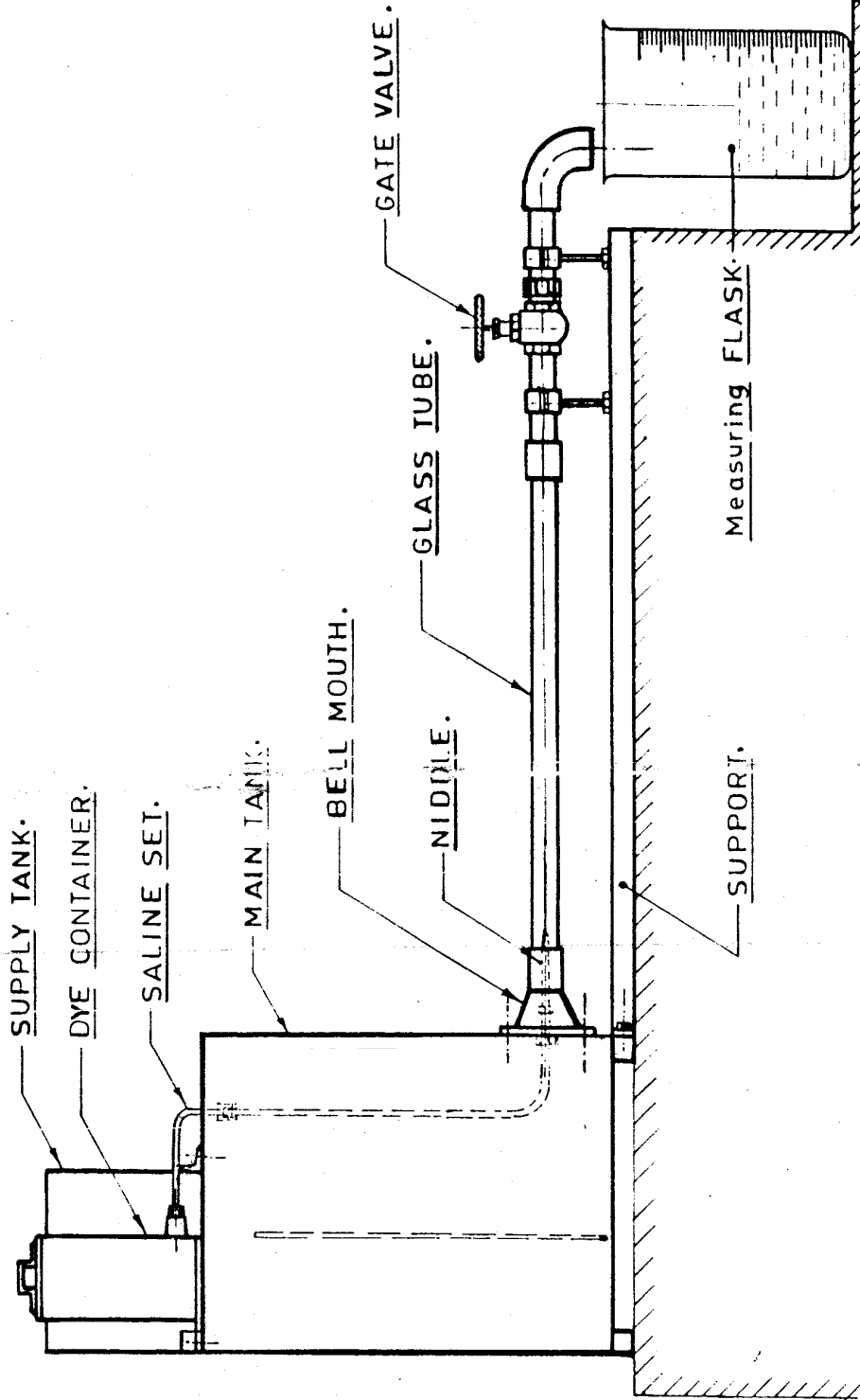

FIG2: Velocity profiles for laminar flow in pipes

FIG3: Fully developed turbulent and laminar profiles for flow in a circular pipe

SCHEMATIC LAY-OUT OF:- REYNOLDS APPARATUS.

FM-1.

FIG.-1.

Type of flow can be decided by using the limits of Reynolds number as given below.

Type of flow	Reynolds Number	
	Pipe flow	Canal flow
Laminar flow	< 2000	< 500
Transition flow	2000 to 4000	500 to 2000
Turbulent	> 4000	> 2000

Stepwise Procedure :

1. Measure dia of pipe and Room Temperature.

2. Fill the tank with water by keeping outlet of glass tube partly opened so that no air is entrapped in the glass tube.

3. When the tank is full close the outlet valve of glass tube and inlet valve of the tank.

4. Allow the water in the tank to come to the state of rest and no disturbance.

5. Maintain constant level of water by opening both inlet valve of tank and outlet valve of the glass tube partly so that velocity of flow is very small.

6. Allow the dye from the dye ejector in to the flow.

7. Allow a certain volume of water to be collected in the measuring tank and Simultaneously start the stop watch and hence compute the discharge.

8. Gradually increase the velocity of flow and measure the discharge.

9. Take six readings till the dye get differed in the flow of water.

10. Repeat the experiment with the decreasing rate of flow.

Observations:

1. Inner diameter of glass tube, D = …………………..

2. Cross – sectional area of glass tube = A = $\dfrac{pD^2}{4}$

3. Mass density of water = p=………………..

4. Average Room temperature= ………………………

5. Dynamic viscosity of water at room temp = μ = …………………

6. Area of tank = l x b = ………………………

7. Name of dye used = ………………………

Observation Table

Table for Calculating Reynolds number

Run No	Volume m³	Time (t) Sec	Discharge (Q) m³/sec	Velocity V = Q/A m/s	Re= pVD μ	Type of flow
1						
2						
3						
4						
5						
6						

Conclusion:

1. As velocity of flow increases Reynolds number………………(Increases decreases).

EXPERIMENT NO: VI -
TO STUDY THE VISCOSITY OF GIVEN OIL WITH TEMPERATURE

AIM : To study the viscosity of given oil with temperature

EQUIPMENTS: Red Wood Viscometer, Measuring Flask, Thermometer &
Stopwatch.

THEORY:

Red Wood Viscometer is based on principle of laminar flow through capillary tube of standard dimension under falling head. The Viscometer consists of vertical cylinder with orifice of centre of base of inner cylinder. The cylinder is surrounded by water both which can maintain temperature of liquid to be tested at required temperature.

The water bath is heated by electric heater. The cylinder which is filled up to fix with liquid whose viscosity is to be determined is heated by water bath to desired temperature. Then orifice is opened and time required to pass 50 cc of liquid is noted. With this arrangement variation of Viscosity with temperature can be studied.

In case of Red Wood Viscometer Kinematic Viscosity and time required to pass 50 cc of liquid are co-related by expression,

$v = C * t$

Where, ν (Nu) = Kinematic viscosity in stoke

t: Time in seconds to collect 50 cc of oil.

C = Equipment Constant (To be found every time by using water)

PROCEDURE:

1. Level instrument with help of circular bubble and leveling foot screws.
2. Fill water bath.
3. Close orifice with ball valve and fill cylinder upto index mark.
4. Record steady temperature of oil.
5. By lifting ball valve, collect 50cc of liquid in measuring flak and measure time required for same.
6. Repeat procedure for different temperatures by heating oil with water bath.

Page28

DIAGRAM:

REDWOOD VISCOMETER.
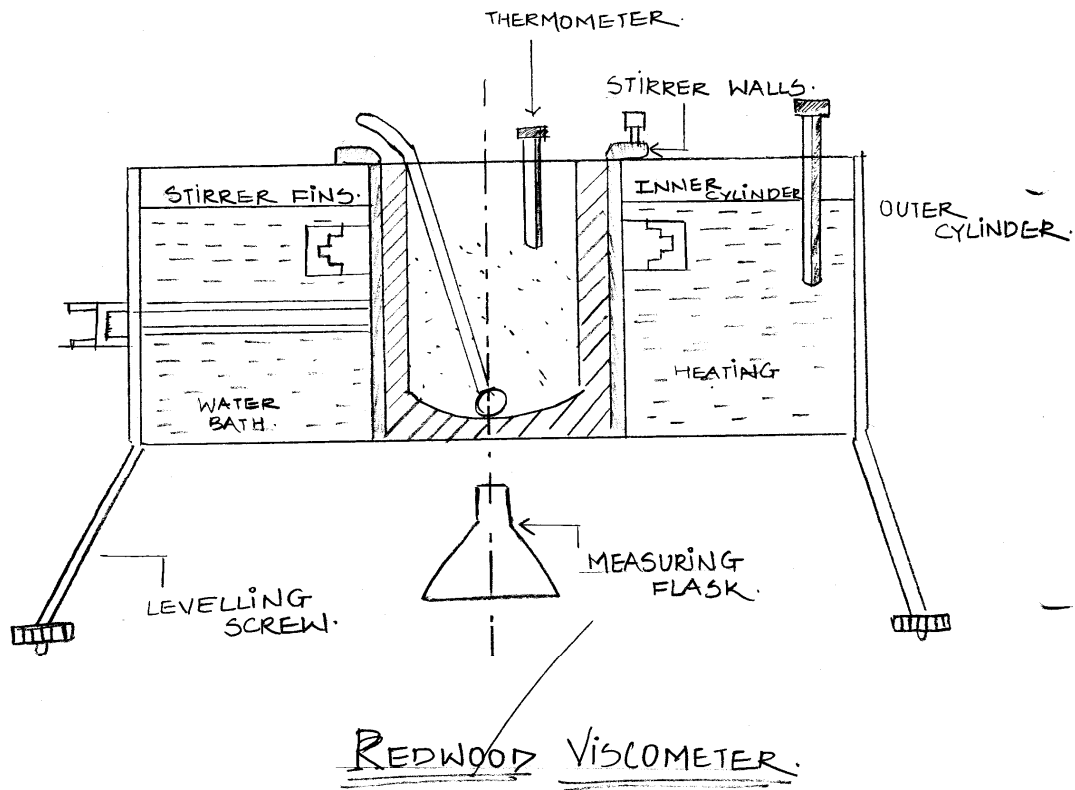
OBSERVATION TABLE:

Temperature (^{0}C)	Time to collect 50cc of oil in time 't' (Sec)	Kinematic Viscosity 'v' in stokes

Kinematic Viscosity (v)   = {0.0026t – 1.175 / t}

Specimen Calculations:-

First we've to find Equipment constant, using water,

Kinematic Viscosity $\nu = C * t$

ν for water at NTP = 0.801

Let t = 25 seconds.

Therefore,

$\nu = C * t$

$0.801 = C * 25$

C = 0.03204 (Using Water)

Then, after taking actual readings,

For 50^0 C,

$\nu_1 = C * t$

$\nu_1 = 0.03204 * 178 / 100$ (divide by 100 to convert it to Stokes or cm^2/s)

$\nu_1 = 0.057$ Stokes = $0.057 * 10^{-4}$ m^2/s

We know that,

$\mu_1 = \rho * \nu_1 = (940 * 0.057 * 10^{-4}) = 0.0535$ Poise   (μ_{Oil}= 940 kg/m^3)

$\mu_2 = \rho * \nu_2 =$………………………………   (μ= Dynamic Viscosity)

$\mu_3 = \rho * \nu_3 =$…………………….……....

CONCLUSIONS:

- Kinematic viscosity of given oil at 40^0 C is ……….. Stokes.

- Kinematic viscosity ………………**decreases/**increases with ………… **increase/** decrease in temperature.

- **Rate** of …………**decrease/**increase of kinematic viscosity ………..**increases/**decreases with …………**increase/**decrease in **temperature.**

EXPERIMENT NO: VII -
MEASUREMENT OF COEFFICIENT OF VELOCITY OF FLUID FLOW USING PITOT STATIC TUBE

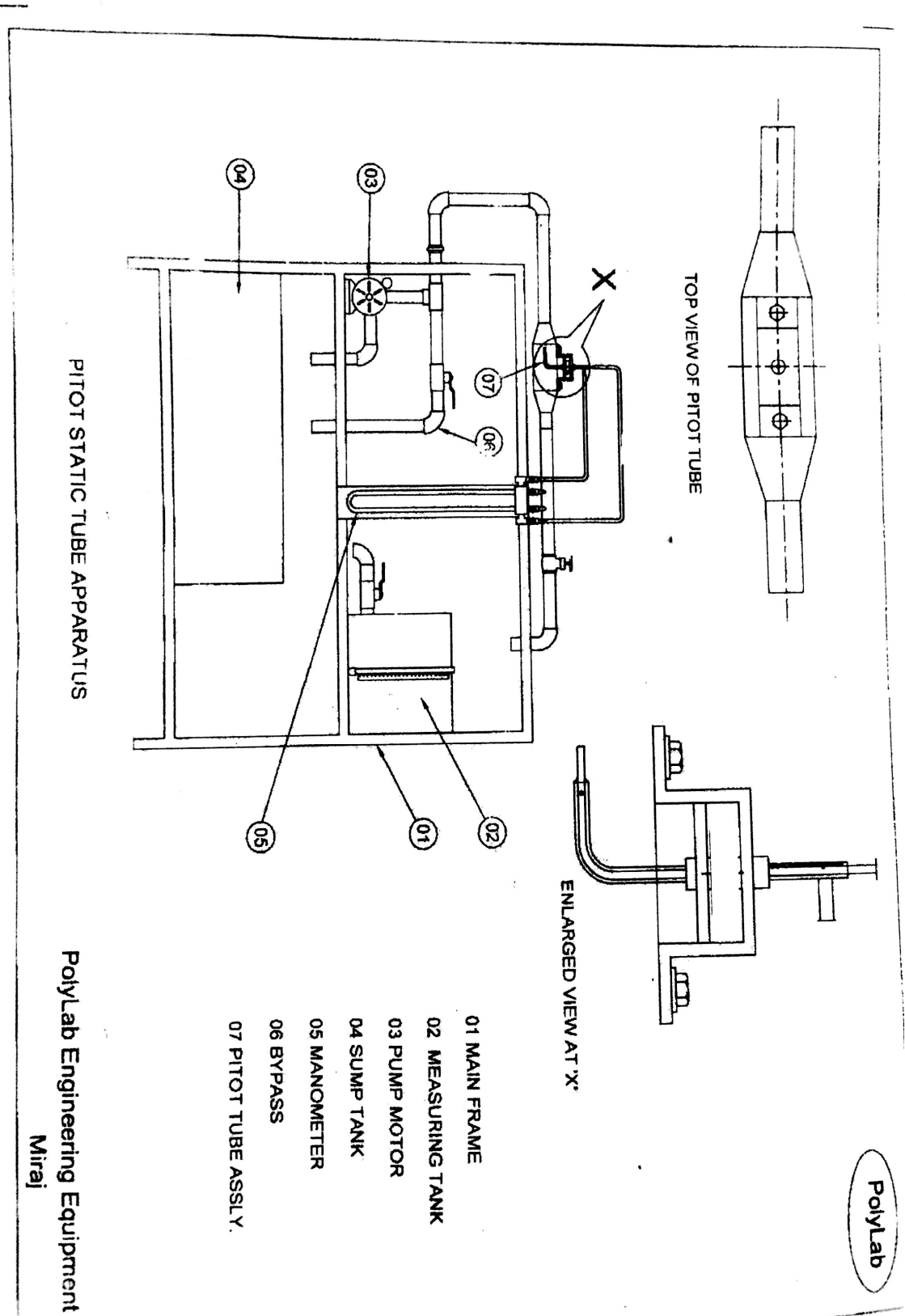**AIM: To find the coefficient of velocity of fluid flow using Pitot static tube.**

INTRODUCTION:

It is a device used for measuring the velocity of flow at any point in pipe or channel. It is based on the principle that if the velocity of flow at a point becomes zero, the pressure there is increased due to the conversion of the kinetic energy into pressure energy. Pitot Tube in simple consists of copper tube, bent at right angle.

The lower end, which is bent through 90^0 is directed in the upstream direction. In this the liquid rises up in the tube due to co0nversion of the kinetic energy into pressure energy. The velocity is determined by measuring the rise of liquid in the tube.

DESCRIPTION:

The apparatus consists of a circular acrylic pipe with a static pressure tapping and a pitot tube with transverse arrangement is provided for determination of velocity profile. Differential manometer is fitted to the frame of the unit to measure various pressures. Gate valve is used to vary the flow which is set up by centrifugal pump. Discharge is measured in a small calibrated tank.

TOP VIEW OF PITOT TUBE

PITOT STATIC TUBE APPARATUS

ENLARGED VIEW AT 'X'

01 MAIN FRAME

02 MEASURING TANK

03 PUMP MOTOR

04 SUMP TANK

05 MANOMETER

06 BYPASS

07 PITOT TUBE ASSLY.

PolyLab Engineering Equipment
Miraj

PolyLab

SPECIFICATIONS:

1. Centrifugal Mono block Pump – 1 HP capacity.

Page32

1. Pitot tube – made from copper tube in tube type. Size of the Tube – 100mm size(approx.).

   Material – Hollow Acrylic Pipe.

3. a) Gate Valve on discharge pipe to the Pitot Static Tube.

   b) Bye pass valve fitted on the suction piping side for controlling the flow.

4. Differential Manometer – Acrylic Body, Range 0 – 400mm with mercury.

5. Measuring Tank : M.S sheet material with FRP Lining from inside and exterior powder

   coating.

    Size : 400mm x 300mm x 300mm ht.

6. Sump Tank : M.S sheet material with FRP Lining from inside and exterior powder coating.

   Size : 900mm x 400mm x 300mm ht.

7. Electronic Racer Type Stop Watch.

8. Support Stand with necessary piping and pressure tapping on the pipe.

PROCEDURE

01. Fill the sump tank with clean water up to $3/4^{th}$ level of the height of the sump tank.

02. Keep the Pitot Static tube position in center of the pipe i.e. '0' position marked on the scale.

03. Keep open the bye pass valve in fully open condition before switching 'On' the pump.

04. Switch on the pump and close the bye pass valve slowly till the pipe is filled with water properly.

05. Adjust the discharge in pipe of Pitot Tube pipe by operating the gate valve gradually, provided to the delivery side of the pipe.

06. Note down the reading when the position of the pitot tube is in center. Then slowly bring the center of the pitot tube towards bottom or towards upwards position.

07. Note down the readings on the Manometer for various positions in upwards and downwards position.

08. After taking down the readings in observation table, measure the time required for 5cm by collecting the water in measuring tank. Note the ball valve of the measuring tank should be in closed position while measuring the flow rate.

09. Now change the flow rate and repeat the above procedure.

DETERMINATION OF VELOCITY PROFILE AT DIFFERENT FLOW RATES.

Adjust the discharge in pipe and Pitot tube at the centre of the pipe. Connect the plastic tube to the manometer and take the difference between the necessary columns. (h_1). Traverse the Pitot tube towards the bottom and top of the pipe and take 2-3 readings at different radius. Calculate the velocity of the water at the particular points and plot the velocity curve as per Fig.

SPECIMEN CALCULATIONS

$$V = \frac{Qa}{\pi/4 \; d^2}$$

Where 'Qa' $= \dfrac{\text{Tank Area x h}}{T} = \dfrac{L \; x \; B \; x \; h}{T}$

$$R_e = \frac{Vd}{\nu}$$ Where d = inside dia. of pipe = 42mm.

('ν' for water $= 10^{-6} \; m^2/sec$)

$$V = \sqrt{2 \, gh}$$

Where 'h' is in m of water i.e. difference in pressure given by pitot tube and static pressure tapping (from Manometer).

GRAPHS

1. Radius Vs. Velocity distribution

MGM'S JNEC, AURANGABAD, MECHANICAL ENGINEERING DEPT.

OBSERVATION TABLE

Sr.No.	Discharge Q (m^3/sec)	't' in sec for collection of 5cm of water	Manometer difference (Hg) measured at different radius w.r.t. centre				
			$r_{20(Up)}$ mm	$r_{10(Up)}$ mm	$r_{o\ Centre}$ mm	$r_{10(Down)}$ mm	$r_{20(Down)}$ mm
1							
2							

$r_{o\ Centre}$ = Pitot tube at centre position

$r_{10\ (Down)}$, $r_{20(Down)}$, = Pitot tube at bottom zone

$r_{10\ (Up)}$, $r_{20(Up)}$, = Pitot tube at top zone

Dia. of Acrylic Pipe = 84 mm.

MGM'S JNEC, AURANGABAD, MECHANICAL ENGINEERING DEPT.

EXPERIMENT NO: VIII -

TO DETERMINE COEFFICIENT OF FRICTION IN PIPES

AIM: **To determine Co-efficient of Friction of Pipes.**

DESCRIPTION :

When a fluid is flowing through the pipe, it is subjected to resistant   flow due to shear forces between the pipe wall and fluid particles also. This resistance is generally called frictional resistance. This resistance depends upon the velocity of flow and area of surface contact. It also depends upon the type of flow i.e. laminar or turbulent. Frictional resistances causes loss of pressure in the direction of flow.

THE APPARATUS

The apparatus consists of three pipes with different I.D.'s. of G.I.Pipes. so the head can be compared for different diameters. Control valve is provided at the outlet of pipes which enables to conduct the experiments at different flow rates i.e. at different velocities.

Tappings are provided along the length of pipes so that drop of the head can be observed along the length of pipe. Each pipe is provided with valve for controlling the heads.

PIPES FRICTION APPARATUS

PolyLab Engineering Equipment
Miraj

PolyLab
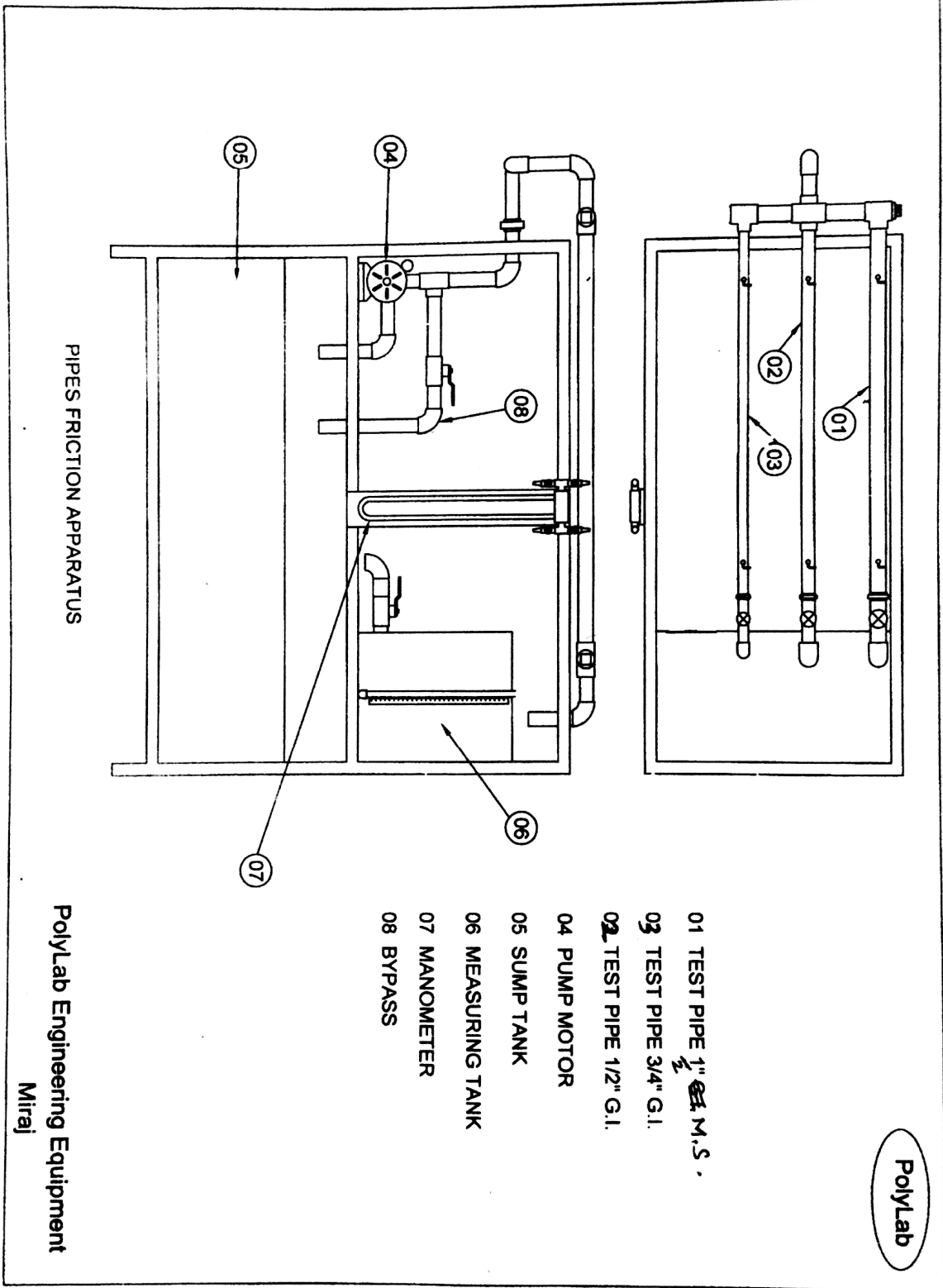
01 TEST PIPE 1" ½ M.S.
03 TEST PIPE 3/4" G.I.
02 TEST PIPE 1/2" G.I.
04 PUMP MOTOR
05 SUMP TANK
06 MEASURING TANK
07 MANOMETER
08 BYPASS

SPECIFICATIONS

A)   Pipe Friction Circuit :

1. ½"G.I.Pipe   (I.D.)   =   15mm.

           (O.D.)   =   21mm.

2. ¾"G.I.Pipe   (I.D.)   =   21mm.

           (O.D.)   =   27mm.

3. ½"M.S.Pipe (I.D.)   =   17 mm.

           (O.D.)   =   23 mm.

4. Pipe circuit   :   Made from GI piping.

5. Measuring Tank   :   Size   -   400 x 300 x 300mm.

           Material -   Made up of 18 SWG M.S.sheet with

           F.R.P. lining from inside.

6. Sump Tank   : Size   -   900mm x 400 x 400mm.

           Material -   Made up of 18 SWG M.S.sheet with

           F.R.P. lining from inside.

7. Diff. Manometer   :   For measuring pressure head.

8. Stop Watch.

9.Mono block pump   :   0.5 HP, Single phase, 230 V.A.C. with bye-pass
   valve and suction piping. Kirloskar Make.

10.Basic Frame & stand made from MS hollow square pipe and Ms angles

Page39

EXPERIMENTAL PROCEDURE

1. Fill up the clean water in the Sump Tank.

2. Open all the outlet valves and start the pump.

3. Check for leakage by closing three of outlet valves, for each pipe. Correct the leakages if any.

4. Open the outlet valves of the pipe to be tested.

5. Remove all the air bubbles from manometer and connecting pipe.

6. Reduce the flow. Adjust outlet valves so that water heads in the manometer will be at readable height.

7. Note down the heads and flow rate.

8. Now, increase the flow and accordingly adjust the outlet valve so that water will not overflow. Note down heads and flow.

9. Repeat the procedure for other pipes.

(**Note :   During measuring the heads, slight variation may occur due to voltage change, valves etc. In such cases, average readings may be taken.**)

MGM'S JNEC, AURANGABAD, MECHANICAL ENGINEERING DEPT.

OBSERVATION TABLE   - For Pipe Friction Set-up.

Pipe Dia.	Head Drop' Hg' in mm.	Flow rate ' t' sec(time for 5 cm. rise in sec.)
½" M.S. Pipe		
½" G.I. Pipe		
¾" G.I. Pipe		

CALCULATIONS

1)   ½" Dia. M.S.Pipe

Area of Pipe $=$ $\dfrac{\pi}{4}$ x DI^2 m^2

   $=$ $\dfrac{\pi}{4}$ x $(\quad)^2$ m^2

Discharge Q$=$ $\dfrac{0.40 \times 0.30 \times 0.05}{T}$ m^3 / Sec.

Velocity of Water $V = \dfrac{Q}{A}$ m/sec.

Let ' f' be the coefficient of friction. Test length of pipe is 1 meter.

For 1 meter length, drop of head h_f

∴ h_f= Manometer difference.

According to Darcy's-Welsh batch equation, head loss due to friction

$$h_f = \frac{f \cdot L \cdot v^2}{2 \cdot g \cdot d}$$

Where,   f = co-efficient of friction.

   L = Length of pipe = 1m

   V = Velocity of water   m/sec.

MGM'S JNEC, AURANGABAD, MECHANICAL ENGINEERING DEPT.

g   =   Gravitational acceleration   =   9.81 m/s^2

d   =   Inside diameter of pipe,   m

Then,

$$f = \frac{h_f \cdot g \cdot d}{2 \cdot L \cdot v^2}$$

The value of coefficient of friction is not constant and depends upon roughness of inner surface

of the pipe and Reynolds's number. Any oil content also affects value of ' f '

   (Repeat the same procedure for other pipes)

CONCLUSIONS :

1) Loss of head due to friction is proportional to length of pipe and square velocity.

2) Loss of head is inversely proportional to inner diameter of the pipe.

3) Average value of ' f' for :

   a) ½"M.S. Pipe.

   b) ½" G.I. Pipe.

   c) ¾"G.I. Pipe.

This page intentionally left blank

Question Bank

FLUID MECHANICS & MACHINES (M)

Mahatma Gandhi Mission's
Jawaharlal Nehru Engineering College
Department of Mechanical Engineering
Fluid Mechanics and Machines (M)
<u>Part A</u>

1. Define fluid.
2. Differentiate between fluid and solid.
3.   Define Specific volume
4. Define Specific gravity.
5. Define Viscosity.
6. Define Compressibility.
7. Define vapor pressure.
8. Define Capillarity.
9. Define Surface tension.
10. Differentiate between Absolute and gauge pressures.
11. Mention two pressure measuring instruments.
12. What is Piezometer?
13. How manometers are classified.
14. What is pitot static tube?
15. Write down the units for dynamic and kinematic viscosity.
16. State Newton's law of viscosity.
17. Differentiate between Newtonian and non Newtonian fluid.
18. Differentiate between ideal and real fluid.
19. What is ideal plastic fluid?
20. Define velocity gradient.
21. What is the difference weight density and mass density?
22. What is the difference between dynamic and kinematic viscosity?
23. Differentiate between specific weight and specific volume.
24. Define relative density.
25. What is vacuum pressure?
26. What is absolute zero pressure?
27. Write down the value of atmospheric pressure head in terms of water and Hg.
28. Define stream line.
29. Define path line.
30. Define streak line.
31. Define steady flow.
32. Define uniform flow.
33. Differentiate between laminar and turbulent flow.
34. How will you classify the flow as laminar and turbulent?
35. Differentiate between compressible and incompressible flow.
36. Differentiate between rotational and irrotational flow.
37. Define stream function.
38. Define velocity potential function.
39. Write down continuity equation for compressible and incompressible fluid.
40. Write down continuity equation in three dimensions.
41. Differentiate between local and convective acceleration.
42. Define circulation.
43. Define flow net.
44. Write down Euler's equation of motion.
45. Write down Bernoulli's equation of motion for ideal and real fluid.

46. State the assumptions made in Bernoulli's equation of motion.
47. Mention the applications of Bernoulli's equation of motion.
48. Mention few discharge measuring devices
49. Draw the Venturimeter and mention the parts.
50. Why the divergent cone is longer than convergent cone in Venturimeter?
51. Compare the merits and demerits of Venturimeter with orifice meter.
52. Why Cd value is high in Venturimeter than orifice meter?
53. What is the difference between Pitot tube and Pitot static tube?
54. What is orifice plate?
55. What do you mean by vena contracta?
56. Define coefficient of discharge.
57. Define coefficient of velocity.
58. Define coefficient of contraction.
59. State Buckingham's Pi Theorem.
60. What is dimensional homogeneity?
61. What is dimensionless number?
62. Mention the methods for dimensional analysis.
63. Mention few important dimensionless numbers.
64. Mention the type of forces acting in moving fluid.
65. Define Reynold's number.
66. Define Froude's number.
67. Define Euler's number.
68. Define Weber's number.
69. Define Mach's number.
70. What is the difference between model and prototype?
71. Mention two application of similarity laws
72. Define geometric similarity.
73. Define kinematic similarity.
74. Define dynamic similarity.
75. What is the difference between fluid kinematics and fluid dynamics?
76. Write down Hagen poiseulle's equation
77. Sketch the velocity distribution for laminar flow between parallel plates.
78. Sketch the shear stress distribution for laminar flow between parallel plates
79. Differentiate between Hydraulic Gradient line and Total Energy line.
80. Write down Darcy -weisback's equation.
81. Mention the application of moody diagram.
82. What is the difference between friction factor and coefficient of friction?
83. What do you mean by major energy loss?
84. List down the type of minor energy losses.
85. What is compound pipe?
86. What do you mean by equivalent pipe?
87. What is the condition for maximum efficiency of power transmission?
88. Define boundary layer thickness.
89. What do you mean by boundary layer separation?
90. Define displacement thickness.
91. Define energy thickness.
92. Define momentum thickness.
93. How boundary layers are classified?
94. Define laminar boundary layer
95. Define turbulent boundary layer.

96. Define laminar sub layer.
97. On what basis, the boundary layer is classified as laminar and turbulent?
98. Define drag force.
99. Define lift force.
100. Define turbine.
101. What are the classifications of turbine
102. Define impulse turbine.
103. Define reaction turbine.
104. Differentiate between impulse and reaction turbine.
105. What is the function of draft tube?
106. Define specific speed of turbine.
107. What are the main parameters in designing a Pelton wheel turbine?
108. What is breaking jet in Pelton wheel turbine?
109. What is the function of casing in Pelton turbine
110. Draw a simple sketch of Pelton wheel bucket.
111. What is the function of surge tank fixed to penstock in Pelton turbine?
112. How the inlet discharge is controlled in Pelton turbine?
113. What is water hammer?
114. What do you mean by head race?
115. What do you mean by tail race?
116. What is speed ratio?
117. What is flow ratio?
118. What is the difference between propeller and Kaplan turbine?
119. Mention the parts of Kaplan turbine.
120. Differentiate between inward and outward flow reaction turbine.
121. What is the difference between Francis turbine and Modern Francis turbine?
122. What is the difference between outward and inward flow turbine?
123. What is mixed flow reaction turbine? Give an example.
124. Why draft tube is not required in impulse turbine?
125. How turbines are classified based on head. Give example.
126. How turbines are classified based on flow. Give example
127. How turbines are classified based on working principle. Give example.
128. What does velocity triangle indicates?
129. Draw the velocity triangle for radial flow reaction turbine.
130. Draw the velocity triangle for tangential flow turbine.
131. Mention the type of characteristic curves for turbines.
132. How performance characteristic curves are drawn for turbine.
133. Mention the types of efficiencies calculated for turbine.
134. Define Hydraulic efficiency
135. Define Mechanical efficiency.
136. Define overall efficiency.
137. Define pump.
138. How pumps are classified?
139. Differentiate pump and turbine.
140. Define Rotodynamic pump.
141. Define Positive displacement pump.
142. Differentiate between Rotodynamic and positive displacement pump.
143. Define cavitation in pump.
144. What is the need for priming in pump?
145. Give examples for Rotodynamic pump

Page 47

146.   Give examples for Positive displacement pump.
147.   Mention the parts of centrifugal pump.
148.   Mention the type of casing used in centrifugal pump.
149.   Why the foot valve is fitted with strainer?
150.   Why the foot valve is a non return type valve?
151.   Differentiate between volute casing and vortex casing.
152.   What is the function of volute casing?
153.   What is the function of guide vanes?
154.   Why the vanes are curved radially backward?
155.   What do you mean by relative velocity?
156.   What is whirl velocity?
157.   What do you mean by absolute velocity?
158.   What is the function of impeller?
159.   Mention the types of impeller used.
160.   Mention the types of efficiencies calculated for pump.
161.   Define Hydraulic efficiency
162.   Define Mechanical efficiency.
163.   Define overall efficiency
164.   Define specific speed of pump.
165.   Mention the type of characteristic curves for pump
166.   How performance characteristic curves are drawn for pump.
167.   Mention the parts of reciprocating pump.
168.   What is the function of air vessel?
169.   What is slip of reciprocating pump?
170.   What is negative slip?
171.   What is the condition for occurrence of negative slip?
172.   What does indicator diagram indicates?
173.   What is the difference between actual and ideal indicator diagram?
174.   Briefly explain Gear pump.
175.   Differentiate between internal gear pump and external gear pump.
176.   Briefly explain vane pump.
177.   What is rotary pump?
178.   Draw the velocity triangle for centrifugal pump.
179.   Draw the indicator diagram fro reciprocating pump.
180.   What is the amount of work saved by air vessel?
181.   Mention the merits and demerits of centrifugal pump.
182.   Mention the merits and demerits of reciprocating pump.
183.   What is separation in reciprocating pump?
184.   How separation occurs in reciprocating pump?
185.   Write down the equation for loss of head due to acceleration in reciprocating pump.
186.   Write down the equation for loss of head due to friction in reciprocating pump.
187.   Differentiate single acting and double acting reciprocating pump.

188.   Define Gauge pressure.

189.   Give the expression for Euler's Equations of motion.

190.   What is Total energy line?

191.   List few minor energy losses in a pipe line.

192. State Buckingham's π - theorem.

193. What is geometric similarity?

194. Define specific speed in a centrifugal pump.

195. What is jet ratio in a Pelton wheel?

196. What is indicator diagram in a centrifugal pump?

197. What is the use of air vessel in a pump?

198. Define fluid.

199. Differentiate between fluid and solid.

200. Define Specific volume

201. Define Specific gravity.

202. Define Viscosity.

203. Define Compressibility.

204. Define vapor pressure.

205. Define Capillarity.

206. Define Surface tension.

207. Differentiate between Absolute and gauge pressures.

208. Mention two pressure measuring instruments.

209. What is Piezometer?

210. How manometers are classified.

211. What is pitot static tube?

212. Write down the units for dynamic and kinematic viscosity.

213. State Newton's law of viscosity.

214. Differentiate between Newtonian and non Newtonian fluid.

215. Differentiate between ideal and real fluid.

216. What is ideal plastic fluid?

217. Define velocity gradient.

218. What is the difference weight density and mass density?

219. What is the difference between dynamic and kinematic viscosity?

220. Differentiate between specific weight and specific volume.

221. Define relative density.

222. What is vacuum pressure?

223. What is absolute zero pressure?

224. Write down the value of atmospheric pressure head in terms of water and Hg.

225.   Define stream line.

226.   Define path line.

227.   Define streak line.

228.   Define steady flow.

229.   Define uniform flow.

230.   Differentiate between laminar and turbulent flow.

231.   How will you classify the flow as laminar and turbulent.

232.   Differentiate between compressible and incompressible flow.

233.   Differentiate between rotational and irrotational flow.

234.   Define stream function.

235.   Define velocity potential function.

236.   Write down continuity equation for compressible and incompressible fluid.

237.   Write down continuity equation in three dimensions.

238.   Differentiate between local and convective acceleration.

239.   Define circulation.

240.   Define flow net.

241.   Write down Euler's equation of motion.

242.   Write down Bernoulli's equation of motion for ideal and real fluid.

243.   State the assumptions made in Bernoulli's equation of motion.

244.   Mention the applications of Bernoulli's equation of motion.

245.   Mention few discharge measuring devices.

MGM'S JNEC, AURANGABAD, MECHANICAL ENGINEERING DEPT.

Part B QUESTIONS (Theory / Derivation)

1. Derive continuity equation in three dimension

2. Derive Bernoulli's equation from Euler's equation of motion.

3. Derive an expression for discharge in Venturimeter

4. Derive an expression for discharge in orifice meter

5. Derive Hagen poiseulle's equation for laminar flow through circular pipe.

6. Derive Darcy-weisback's equation for flow through pipes

7. Explain the types of similarities.

8. Derive an expression for specific speed for pump.

9. Derive an expression for specific speed for turbine.

10. Explain with neat sketch the working principle of Centrifugal pump

11. Explain with neat sketch the working principle of Reciprocating pump.

12. Explain with neat sketch the working principle of Pelton wheel turbine

13. Explain with neat sketch the working principle of Kaplan turbine

14. Explain with neat sketch the working principle of Reaction turbine

15. Explain with neat sketch the working principle of rotary pump(Gear / Vane pump)

16. Derive the efficiencies in centrifugal pump

17. Derive the amount of work saved by air vessel in reciprocating pump.

...All the Best...