SCHEME : K

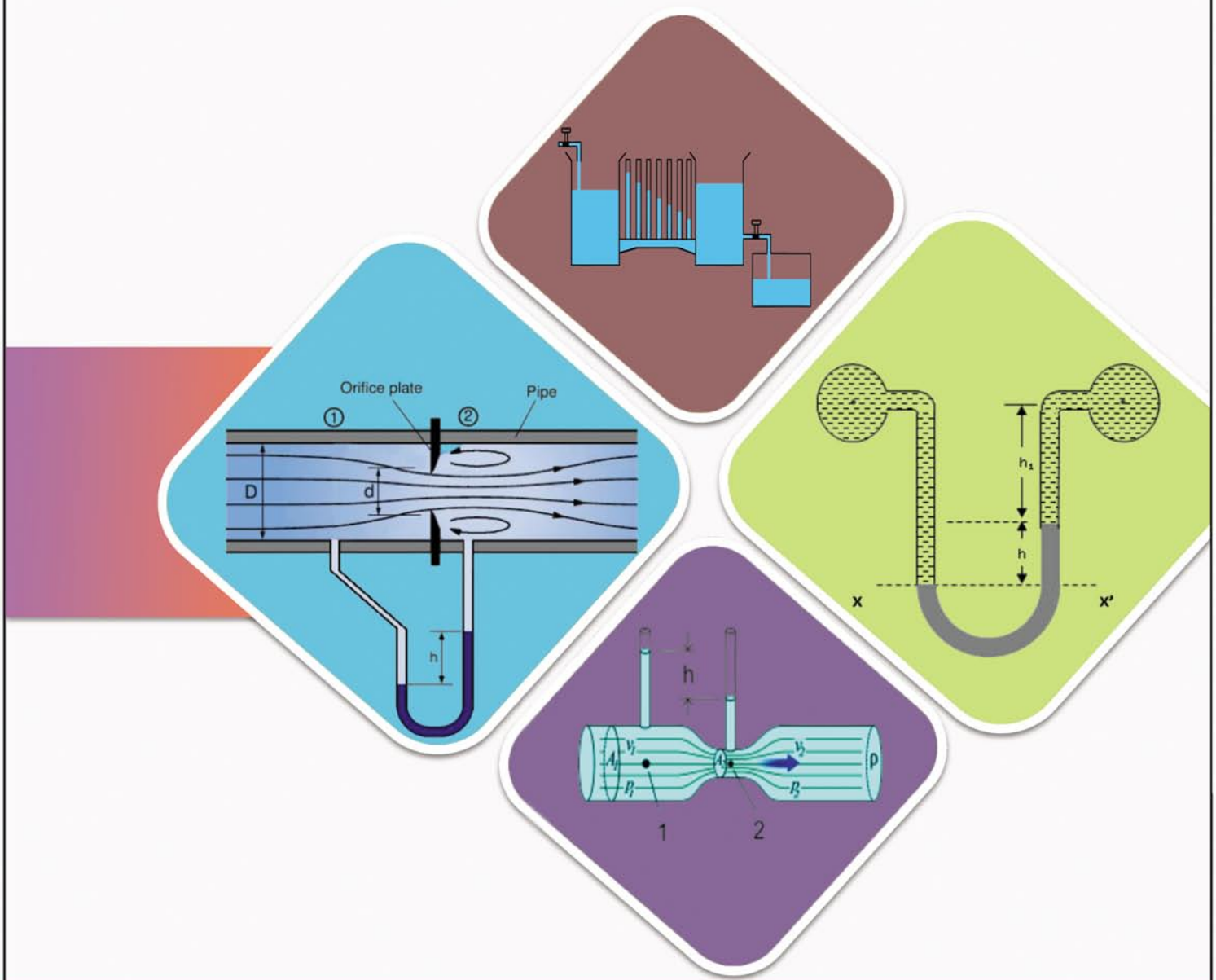
Name : _____

Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

HYDRAULICS
(314303)



CIVIL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF
TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION:

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION:

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY:

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES:

MSBTE believes in the following:

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education.

A Laboratory Manual

For

HYDRAULICS

(314303)

SEMESER-IV

“K-SCHEME”

(AL/CE/CR/CS/LE)

Maharashtra State

Board of Technical Education, Mumbai.

(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai – 400051,
(Printed On _____, 2024)

Maharashtra State
Board of Technical Education, Mumbai.

Certificate

This is to certify that Mr. / Ms. ……..

Roll No……of Fourth Semester of Diploma in …….....of Institute,……..…… ……(Code:……) has completed the term work satisfactorily in course **Hydraulics (314303)** for the academic year 20…… to 20…… as prescribed in the curriculum**.**

Place: …… Enrollment No: ……..

Date: ……. Exam. Seat No: ……

Subject teacher **Head of the Department** **Principal**

Seal of Institution

PREFACE

The development of the critically important industry-relevant abilities and skills is the main goal of any engineering laboratory or field work in the technical education system. In light of this, MSBTE developed the most recent "K" Scheme curricula for engineering diploma programs, emphasizing outcome-based learning. As a result, a sizable portion of the program is dedicated to practical work. This demonstrates how crucial laboratory work is in helping teachers, instructors, and students understand that every minute of lab time must be used efficiently to create these outcomes rather than wasting it on unnecessary activities. Every practical has thus been created to operate as a "vehicle" to help each student acquire this industry-identified capability in order to ensure the effective implementation of this outcome-based curriculum. The "chalk and duster" practice in the classroom is a challenging way to build practical skills. As a result, the development team of the "K" scheme laboratory manual focused on the intended results when creating the practical, as opposed to the customary approach of performing practical's to "verify the theory".

This lab manual is intended to support all parties involved, particularly the students, instructors, and teachers, in helping the students achieve the pre-established goals. It is required of every student to read through the relevant practical process in its entirety and comprehend the bare minimum of theoretical background related to the practical at least one day in advance of the practical. As a crucial starting point for carrying out the practical, each exercise in this handbook starts with establishing the competency, industry-relevant skills, course outcomes, and practical results. After that, the students will learn about the abilities they will acquire through the process outlined there and the safety measures that must be followed, which will enable them to use in addressing real-world situations in their professional life.

This manual also offers guidance to educators on how to manage resources so that students follow protocols and safety measures methodically and meet learning objectives. This allows teachers and instructors to effectively support student-centered lab activities through each practical exercise.

Today's globalized world has witnessed tremendous technological breakthroughs in surveying equipment and technology. Currently available accurate digital surveying tools are employed because of their speed, precision, and ease of use. The disciplines of civil engineering, mining engineering, environmental engineering, transportation engineering, and marine engineering heavily rely on these tools and applications. Given the importance of remote sensing and Geographic Information Systems (GIS) and their widespread usage in mapping and storing spatial data, it is expected that students will have a basic understanding of these subjects in order to use them in the field. Students who complete this course will have the necessary abilities and competences to perform tasks linked to surveys.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program outcome (POs)

PO 1. Basic & Discipline specific knowledge: Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.

PO 2. Problem Analysis: Identify and analyze well defined engineering problems using codified standard methods.

PO 3. Design /Development Solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO 4. Engineering tools experimentation and testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO 7. Lifelong learning: Ability to analyze individual needs and engage in updating in context of technological changes.

List of Relevant Skills

On the successful completion of the course the students will acquire the required industry relevant skills and they will be able to:

1. Determine the physical properties of given fluid and the pressure parameters obtained from pressure measuring devices in liquids.
2. Determine the resultant pressure and its position for given situation of liquid in a tank.
3. Apply Bernoulli's theorem apparatus to obtain total energy line for floe in closed conduit of varying cross sections.
4. Determine the friction factor for the given pipe by using friction factor apparatus.
5. Analyze the minor losses in different pipe fittings.
6. Use of venturimeter and orifice to determine the discharge in a pipe and tank.

Guidelines to teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each practical.
3. Involve students in performance of each practical.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.

Instructions to Students

1. Organize the work in the group and make record all programs.
2. Students shall develop maintenance skill as expected by industries.
3. Student shall attempt to develop related hand-on skills and gain confidence.
4. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
5. Student shall refer technical magazines.
6. Student should develop habit to submit the practical on date and time.
7. Student should well prepare while submitting write-up of exercise.
8. Attach /paste separate papers wherever necessary.

Practical Course outcome matrix:

- CO1 - Interpret the pressure parameters obtained from pressure measuring devices in liquids.
- CO2 - Determine total hydrostatic pressure and center of pressure for different conditions.
- CO3 - Calculate relevant parameters for given fluid flow.
- CO4 - Determine loss of head for flow through pipe in given situation.
- CO5 - Find the relevant fluid flow parameters in open channels.

Pr. No.	Title of the Practical	Mapped Course Outcome				
		CO1	CO2	CO3	CO4	CO5
01	*Computation of physical properties of given fluid (tap water and muddy water).	√	--	--	--	--
02	Computation of physical properties of given liquid (oil and Mercury).	√	--	--	--	--
03	Use of Bourdon Gauge to measure the pressure at a given point.	√	--	--	--	--
04	*Use of U tube differential manometer to measure the pressure difference between two given points.	√	--	--	--	--
05	*Find the resultant pressure and its position for given situation of liquid in a tank.	--	√	--	--	--
06	Use of Reynold's apparatus to determine type of flow.	--	--	√	--	--
07	*Use of Bernoulli's apparatus to obtain Total Energy Line for flow in closed conduit of varying cross sections.	--	--	√	--	--
08	*Use of Friction factor Apparatus to determine the friction factor for the givenpipe.	--	--	--	√	--
09	*Determination of minor losses in pipe for sudden contraction and sudden enlargement.	--	--	--	√	--
10	Determination of minor losses in pipe fitting such as Bend and Elbow.	--	--	--	√	--
11	*Calibration of Venturimeter to find out the discharge in a pipe.	--	--	--	√	--
12	Calibration of Orifice to find out the discharge through a tank.	--	--	--	√	--
13	*Determination of efficiency of given Centrifugal Pump.	--	--	--	√	--
14	*Use of 'V' notch to measure the discharge through open channel.	--	--	--	--	√
15	Use of rectangular notch to measure the discharge through open channel.	--	--	--	--	√

Content page

List of Practical's and Formative Assessment sheet.

Pr. No	Title of the Practical	Page No.	Date of performance	Date of Submission	Assessment marks	Dated sign of teacher	Remarks (if any)
1	*Computation of physical properties of given fluid (tap water and muddy water).						
2	Computation of physical properties of given liquid (oil and Mercury).						
3	Use of Bourdon Gauge to measure the pressure at a given point.						
4	*Use of U tube differential manometer to measure the pressure difference between two given points.						
5	*Find the resultant pressure and its position for given situation of liquid in a tank.						
6	Use of Reynold's apparatus to determine type of flow.						
7	*Use of Bernoulli's apparatus to obtain Total Energy Line for flow in closed conduit of varying cross sections.						
8	*Use of Friction factor Apparatus to determine the friction factor for the given pipe.						
9	*Determination of minor losses in pipe for sudden contraction and sudden enlargement.						
10	Determination of minor losses in pipe fitting such as Bend and Elbow.						
11	*Calibration of Venturimeter to find out the discharge in a pipe.						
12	Calibration of Orifice to find out the discharge through a tank.						
13	*Determination of efficiency of given Centrifugal Pump.						

Pr. No	Title of the Practical	Page No.	Date of performance	Date of Submission	Assessment marks	Dated sign of teacher	Remarks (if any)
14	*Use of 'V' notch to measure the discharge through open channel.						
15	Use of rectangular notch to measure the discharge through open channel.						
Total marks :							

These marks are to transferred in preform published by MSBTE
*Marked Practical (LLOs) are mandatory.
Minimum 80% of above list of lab experiment are to be performed.
Judicial mix of LLOs are to be performed to achieve desired outcome.

Practical No. 1: Computation of physical properties of given fluid (tap water and muddy water)

I. Practical Significance

Physical properties of the liquids are to be understood and fluid characteristics have a crucial effect on equipment performance and life. Comparative study of liquids can be made after knowing their physical properties.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO1- Interpret the pressure parameters obtained from pressure measuring devices in liquids.

IV. Laboratory Learning Outcome(s)

LLO 1.1 Determine physical parameters of given sample of tap water and muddy water

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background

Physical properties of liquids like specific mass, specific weight and Specific gravity and their SI units.

Specific mass (Mass density): It is the mass per unit volume. The unit of mass density is kg/m^3.

ρ for water = 1000 kg/m^3

$$\rho = \frac{Mass}{Volume} = m/v$$

Specific weight or Unit weight or Weight density (γ): It is the weight per unit volume.

γ= weight of given liquid/weight of water at 4^0c

=W/volume

= mg/volume

= ρ g

Where, ρ is the mass density, g is the acceleration due to gravity.
The unit of specific weight is N/m^3.
Weight density for potable water is 9810 N/m^3

Specific gravity or Relative density of a liquid (SL): It is the ratio of specific weight of liquidto the specific weight of pure water at 4°C.

$$S_L = \frac{\text{Specific weight of liquid}}{\text{Specific weight of water at } 4^0c}$$

$$S_L = \gamma_L / \gamma_W \quad \text{or} \quad S_L = \rho_L / \rho_W$$

Specific gravity has no units.

Specific gravity of potable water is "1.0".

VII. Experimental Set-up

Fig 1.1 Measuring jar

Fig 1.2 Measuring jug

Fig 1.3. Digital weighing balance

VIII. Required resources/equipment:

Sr. No	Particulars	Specification	Quantity	Remark
1	Volume measuring devices like measuring cup or graduated cylinder.	Standard make	**1**	For each batch
2	Digital weighing balance.	Standard make	**1**	For each batch

IX. Precautions to be followed

1. Measure the volume and weight accurately.
2. Handle mercury with care

X. Procedure

1. Measure the volume of the given liquids using measuring jar or jug.
2. Measure the weight of the given liquids using digital weighing balance.
3. Find specific mass, specific weight and Specific gravity of the given liquids usingformulae.

XI. Observations and Calculations

Sr. No.	Mass (m)	Volume	Specific mass, ρ = mass / Volume	Specific Weight, γ_L = weight / Volume	Specific Gravity, $S_L = \gamma_L / \gamma_W$ or $= \rho_L / \rho_W$
1					
2					
3					

Sample Calculations:

1. **Specific mass, ρ = mass / Volume**
2. **Specific Weight γ_L = weight / Volume = w / g = mg / volume**
   Where, g is the acceleration due to gravity
3. **Specific Gravity S_L = = γ_L / γ_w**

$$= \rho_L / \rho_w$$

XII. Results

Tap water:

1. Specific mass, $\rho_{\text{tap water}}$ =_____ kg/m^3
2. Specific Weight $\gamma_{\text{tap water}}$ =_____ N/m^3
3. Specific Gravity $S_{\text{tap water}}$ =_____

Muddy water :

1. Specific mass, $\rho_{\text{muddy water}}$ =_____ kg/m^3
2. Specific Weight $\gamma_{\text{muddy water}}$ =_____ N/m^3
3. Specific Gravity $S_{\text{muddy water}}$ =_____

XIII. Interpretation of results (Give meaning of the above obtained results)

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XIV. Conclusions and Recommendations (if any)

(Actions/decisions to be taken based on the interpretation of results).

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XV. Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Define Specific weight, specific mass and specific gravity.
2. State the capacity of the measuring cylinder used.
3. State the maximum weighing capacity of digital balanced used.
4. State the least count of the digital balance used.
5. Compare two given liquids based on specific gravity.

[Space to Write Answers]

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XVI. References / Suggestions for further Reading

Sr. No.	Link	Description
1	https://www.youtube.com/watch?v=A0BuHEqDm88	Introduction to Physical properties of fluid
2	https://www.youtube.com/watch?v=un8qLFx6qmo	Introduction to Physical properties of water

XVII. Suggested Assessment Scheme

Performance Indicators		**Weightage (%)**
Process related: 15 Marks		**60%**
1	Performing the test / Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related: 10 Marks		**40%**
1	Conclusions	20%
2	Answer to practical related questions	10%
3	Submission of report in time	10%
Total : 25 Marks		**100%**

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 2: Computation of physical properties of given liquid (oil and Mercury)

I. Practical Significance

Physical properties of the liquids are to be understood and fluid characteristics have a crucial effect on equipment performance and life. Comparative study of liquids can be made after knowing their physical properties.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO1- Interpret the pressure parameters obtained from pressure measuring devices in liquids.

IV. Laboratory Learning Outcome(s)

LLO 2.1 Determine the physical properties of given sample of oil and Mercury

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background

Physical properties of liquids like specific mass, specific weight and Specific gravity and their SI units.

Specific mass (Mass density): It is the mass per unit volume. The unit of mass density is kg/m^3.

ρ for water = 1000 kg/m^3

ρ for water = 1000 kg/m^3

$\rho = \frac{Mass}{Volume}$ = m/volume

Specific weight or Unit weight or Weight density (γ): It is the weight per unit volume.

γ = weight of given liquid/weight of water at 4^0c

=W/volume

= mg/volume

$= \rho g$

Where, ρ is the mass density, g is the acceleration due to

gravityThe unit of specific weight is N/m^3.

Weight density for potable water is 9810 N/m^3

Specific gravity or Relative density of a liquid (S_L): It is the ratio of specific weight of liquidto the specific weight of pure water at 4oC.

$$= \frac{\text{Specific weight of liquid } S_L}{\text{Specific weight of water at } 4^oC}$$

$$S_L = \gamma_L / \gamma_W, \quad \text{or} \quad S_L = \rho_L / \rho_W$$

Specific gravity has no units.

Specific gravity of potable water is "1.0"

VII. Experimental Set-up

Fig 2.1 Measuring jar

Fig 2.1 Measuring jug

Fig 2.1 Digital weighing balance

VIII. Resources required

Sr. No	Particulars	Specification	Qty.	Remark
1	Volume measuring devices like Measuring cup or graduated cylinder.	Standard make	1	For each batch
2	Digital weighing balance.	Standard make	1	For each batch

IX. Procedure

1. Measure the volume of the given liquids using measuring jar or jug.

2. Measure the weight of the given liquids using digital weighing balance.
3. Find specific mass, specific weight and Specific gravity of the given liquids using formulae.

X. Precautions to be followed

1. Measure the volume and weight accurately.
2. Handle mercury with care.

XI. Observations and Calculations

Sr. No.	Mass (m)	Volume	Specific mass, ρ = mass / Volume	Specific Weight, γ_L = weight / Volume	Specific Gravity, S = γ_L / γ_W or = ρ_L / ρ_w
1					
2					
3					

Sample Calculations:

1. Specific mass, ρ = mass / Volume
2. Specific Weight γ_L = weight / Volume = w / g = mg / volume
   Where, g is the acceleration due to gravity
3. Specific Gravity $S_L = = \gamma_L / \gamma_W$

XII. Results

Oil:

1. Specific mass, ρ_{oil} =_____ kg/m^3
2. Specific Weight γ_{oil} =_____ N/m^3
3. Specific Gravity S_{oil} =_____

Mercury:

1. Specific mass, $\rho_{mercury}$ =_____ kg/m^3
2. Specific Weight $\gamma_{mercury}$ =_____ N/m^3
3. Specific Gravity $S_{mercury}$ =_____

XIII. Interpretation of results(Give meaning of the above obtained results)

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XIV. Conclusions and Recommendations if any

(Actions/decisions to be taken based on the interpretation of results).

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XV. Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the capacity of the measuring cylinder used.
2. State the maximum weighing capacity of digital balanced used.
3. Compare two given liquids based on specific gravity.
4. Name the oil used during the experiment.

[Space to Write Answers]

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XVI. References / Suggestions for further Reading

Sr. No.	Link	Description
1	https://www.youtube.com/watch?v=A0BuHEqDm88	Introduction to Physical properties of fluid
2	https://www.youtube.com/watch?v=un8qLFx6qmo	Introduction to Physical properties of water

XXI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related: 15 Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related: 10 Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 03: Use of Bourdon Gauge to measure the pressure at a given point.

I. Practical Significance

Bourdon pressure gauge is mechanical device used to measure the pressure of a liquid/gas at a point. The Bourdon pressure gauge uses the principle that a flattened tube tends to straighten or regain its circular form in cross-section when pressurized.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO1- Interpret the pressure parameters obtained from pressure measuring devices in liquids.

IV. Laboratory Learning Outcome(s)

LLO 3.1 Measure the pressure at a given point using Bourdon Gauge.

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background

The Bourdon pressure gauge uses the principle that a flattened tube tends to straighten or regain its circular form in cross-section when pressurized. This change in cross-section may be hardly noticeable, involving moderate stresses within the elastic range of easily workable materials. The strain of the material of the tube is magnified by forming the tube into a C shape or even a helix, such that the entire tube tends to straighten out or uncoil elastically as it is pressurized.

VII. Experimental Set-up

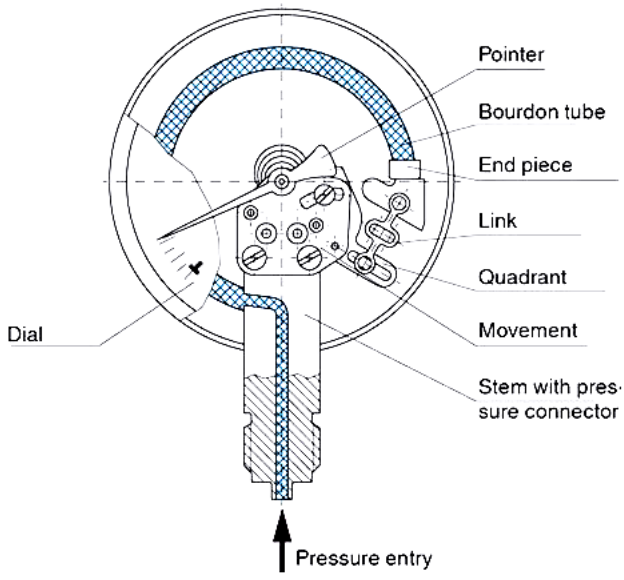

Fig 3.1. ***Bourdon's Pressure gauge***

VIII. Requires Recourses/Apparatus/Equipment with Specifications

Sr. No	Particulars	Specification	Quantity	Remark
1	Bourdon's pressure gauge	Standard make	1	For each batch

IX. Procedure

1. Start fluid flow in the pipe line by opening the valve.
2. Note the units indicated on the Bourdon's pressure gauge.
3. Note the least count of the Bourdon's pressure gauge.
4. Observe and note the magnitude of the pressure.
5. Repeat the experiment by rotating the valve to 2-3 different position and take the reading of the pressure gauge.

X. Precautions to be followed

1. Use the apparatus carefully.
2. Observe the readings with precision.

XI. Observations and Calculations (Use blank sheet provided if space not sufficient)

Sr. No	Observed pressure intensity(p) in N/m^2
1	
2	
3	

XII. Results

a. Least count of the Bourdon's pressure gauge is_____.

b. Pressure intensity at the given point is_____.

i. _____ N/m^2

ii. _____N/m^2

iii. _____N/m^2

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XIII. Interpretation of results (Give meaning of the above obtained results)

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XIV. Conclusions and Recommendations if any (Actions/decisions to be taken based on the interpretation of results).

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XV. Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. How does Bourdon's tube pressure gauge works.
2. State the least count of the Bourdon's pressure gauge.
3. State the practical situations in day to day life where you observe /use the gauge.

4. What Zero of Bourdon's pressure gauge indicates? Can it measure negative pressure?

[Space to Write Answers]

XVI. References / Suggestions for further Reading

Sr. No.	Link	Description
1	https://www.youtube.com/watch?v=uBdTxTp_qLI	How Bourdon Gauge Pressure works
2	https://www.youtube.com/watch?v=G9zIW4Xclp4	How to read pressure gauge
3	https://www.youtube.com/watch?v=w0bIxKB8maw	Operation of Bourdon Gauge Pressure

XVII. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Performing the test / Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10 Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total: 25 Marks		**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 04: Use of U tube differential manometer to measure the pressure difference between two given points.

I. Practical Significance

Pressure difference between the two points is essential to decide the direction of flow. Differential manometers are also used to compare the pressure of two different containers. They reveal both which container has greater pressure and how large the difference between the two is.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO1- Interpret the pressure parameters obtained from pressure measuring devices in liquids.

IV. Laboratory Learning Outcome(s)

LLO 4.1 Measure the pressure difference between two given points using U tube differential manometer

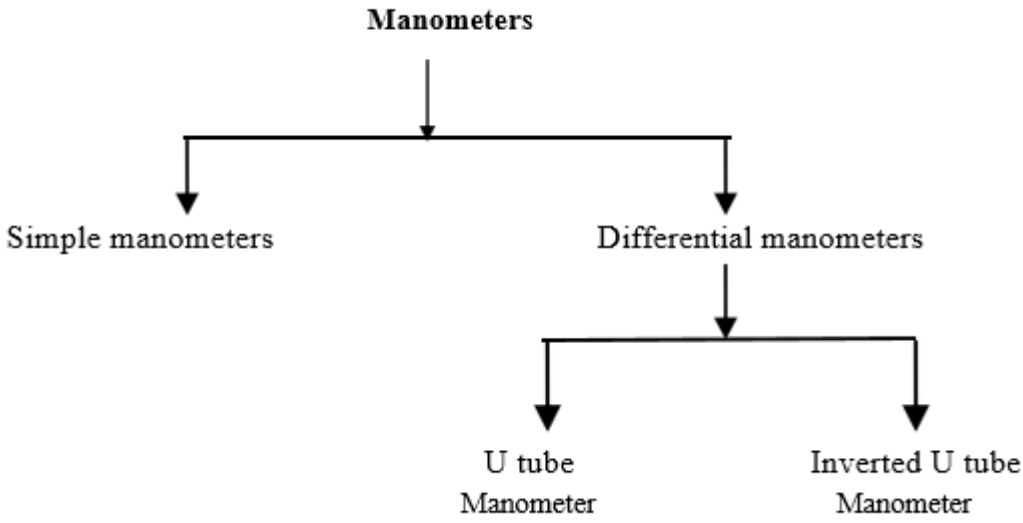
V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background

Manometer are pressure measuring devices generally used in laboratory. Manometers overcome the limitations in the use of piezometers. Manometers can measure high, low, negative pressure of liquids and gases. The only disadvantage of manometers is that they are not easy to carry or transport. Mercury is used as manometric liquid in simple and U tube differential manometers where in inverted U tube manometer "the fluid which is lighter than the fluid flowing through the pipe line can be used as manometric fluid."

The classification is shown below.



Calculate the pressure of the liquid at a point.

$P = \gamma h$

Where ,

p = intensity of pressure,

h = rise of liquid in piezometer and

γ = Specific weight of the liquid

A differential U tube manometer is a device used to measure the difference in pressure between two points of the same or different pipe lines. It consists of a U tube containing heavy liquid and its two ends are connected to the points whose difference of pressure is required to be measured.

VII. Experimental Set-up

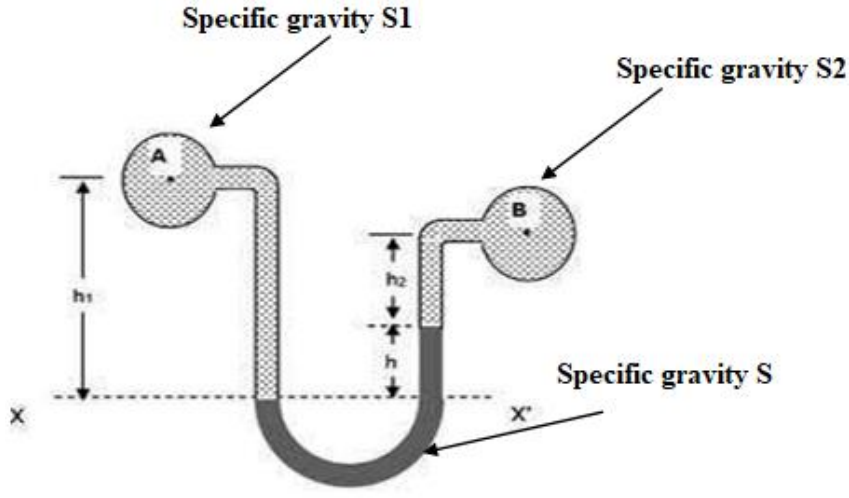


Figure 1 : U-Tube differential manometer

$$\frac{P_A}{\gamma} + h_1 S_1 = \frac{P_B}{\gamma} + h_2 S_2 + hS_3$$

$$\frac{P_A}{\gamma} - \frac{P_B}{\gamma} = h_2 S_2 + hS_3 - h_1 S_1$$

$$(H_A - H_B) = h_2 S_2 + hS_3 - h_1 S_1$$

XVIII. Required resources/equipment:

Sr. No	Particulars	Specification	Quantity	Remark
1	U tube differential manometer	Standard make	**1**	For each batch

VIII. Procedure:

1. Start the fluid flow in pipe by opening the valve.
2. Observe the manometer connected to pipe through which liquid is flowing.
3. Note the difference of heavy liquid in U tube.
4. Note the distance of center of pipe from heavy liquid in the right limb and left limb.
5. Calculate the difference of pressure head at A and B.
6. Calculate the difference of pressure intensities.
7. Repeat the experiment by changing the rate of flow by operating the valve.

IX. Precautions to be followed

1. Use the apparatus carefully.
2. Observe the readings with precision.
3. Handle mercury with care.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

Specific gravity of liquid flowing in pipe A, S_1 =

Specific gravity of liquid flowing in pipe B, S_2 =

Specific gravity of manometric liquid, S_3 =

Sr. No.	Manometer readings			Formula $H_A - H_B = S_3h + S_2h_2 - S_1h_1$	Pressure difference= $p_A - p_B = \gamma (h_A - h_B)$
	h_1	h_2	H		
1					
2					
3					

Sample Calculation:

i. $H_A - H_B = S_3h + S_2h_2 - S_1h_1$

ii. $P_A - P_B = \gamma (h_A - h_B)$

XI. Results

Pressure difference = $P_A - P_B$ =

1. **=_____ N/m^2**
2. **=_____ N/m^2**
3. **=_____ N/m^2**

XII. Interpretation of results (Give meaning of the above obtained results)

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XIII. Conclusions and Recommendations (If any)

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XIV. Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State the principle on which Differential U tube manometer works.
2. Write two applications of manometers.
3. Name the liquid flowing in the pipe line and its specific gravity.
4. Write the situation when inverted manometers are used.
5. Mercury does not stick to the walls of the manometer. Give reasons.
6. Draw and write the formula /expression for calculating pressure difference when boththe pipes are at the same level, with the same and different liquids flowing in the pipes.
7. With the help of neat diagram show positive and negative pressure at a point .in asimple U tube manometer.
8. Name the equipment where differential manometer is used.

[Space to Write Answers]

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XV. References / Suggestions for further Reading

Sr. No.	Link	Description
2	https://www.youtube.com/watch?v=zvc_hRg-0Ns	Introduction to Differential U-tube manometer

XVII. Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Performing the test / Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10 Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 05: Find the resultant pressure and its position for given situation of liquid in a tank.

I. Practical Significance

Pressure exerted by the liquid on the walls and the base of the container is important while designing the containers. The stability of the containers depends on the total pressure exerted on them. In this experiment pressure exerted by the liquid on the walls and the base of the container is determined.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO2 - Determine total hydrostatic pressure and center of pressure for different conditions.

IV. Laboratory Learning Outcome(s)

LLO 5.1 Calculate the resultant pressure & its position for given liquid in a tank.

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background

1. Calculate the pressure of the liquid at a point using formula for Piezometer. Hydrostatic pressure (total pressure) is the pressure exerted by a fluid which is at reston the surface with which fluid is in contact.
2. Centre of pressure is the point where the total hydrostatic pressure acts.
3. Center of pressure is always below the center of gravity of the body/surface.

VII. Experimental Set-up

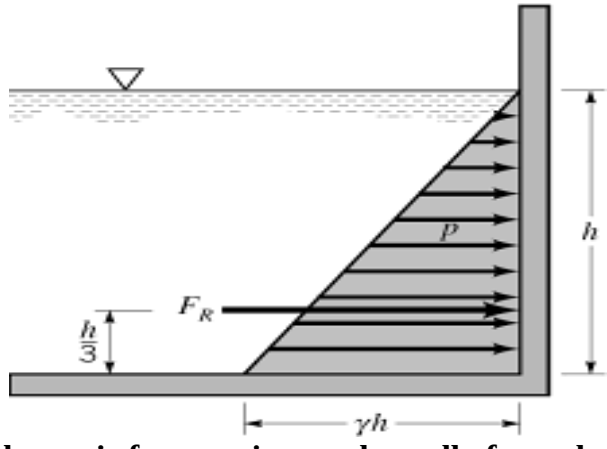

Fig 5.1. Hydrostatic force acting on the wall of a tank

VIII. Resources required

Sr. No	Particulars	Specification	Quantity	Remark
1	Tank containing liquid	Standard make	1	For each batch

IX. Procedure

1. Measure the area of the tank by knowing its length (L) and width (B).
2. Fill the tank up to certain height.
3. Note the piezometric reading and record the pieozometric head h.
4. Calculate the pressure intensities on the walls and the base of the container.
5. Find the position of centre of pressure.
6. Experiment is repeated for different heads of liquid in the tank.

X. Precautions to be followed

1. Use the apparatus carefully.
2. Observe the readings with precision.

XI. Observations and Calculations

1. Area of the tank = A= L x B =_____m^2.
2. Specific gravity of Liquid in tank, S_1 =_____.

Sr No	Piezometric Head, h	Total Hydrostatic pr. on the base, of the tank $P_1 = \gamma_L A h$	Total Hydrostatic pr.on the wall, of the tank $P_2 = ½ \gamma_L h^2$
1			
2			
3			

Sample calculations

1. $\gamma_L = \rho \times g$

$P = w A h = \gamma_L A h$

Where, γ_L= weight

density of liquidg =

gravitational acceleration

A = area of Bottom of tank

h = Head of water above the base.

2. Piezometric head in the tank = h =
3. Total Hydrostatic pressure on the base, $P_1 = \gamma_L A h$ =
4. Total Hydrostatic pressure on the wall, $P_2 = ½ \gamma_L h^2$ =

XII. Results

Total Hydrostatic pressure on the base, P_1

a. _____ N
b. _____N
c. _____N

Total Hydrostatic pressure on the Wall, P_2

a. _____ N
b. _____N
c. _____N

XIII. Interpretation of results (Give meaning of the above obtained results)

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XIV. Conclusions and Recommendations (if any)

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XV. Practical Related Questions

1. State the volume of the tank used.
2. Mention the specific gravity of the liquid in the tank.
3. Is the total hydrostatic pressure acting on the wall and the base are same or not? Givereasons
4. Define total pressure and center of pressure.
5. Draw pressure diagrams for the following cases
   a. Pressure due to one type of liquid on the side of the surface.
   b. Pressure due to different types of liquids one over another on one side of the tankonly.
   c. Resultant Pressure acting on the wall due to liquids of same or different specificgravity on both sides of wall.

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XVI. References / Suggestions for further Reading

Sr. No.	Link	Description
1	. https://www.youtube.com/watch?v=-BB-bCE8klg	Total pressure and centre of pressure

XVII. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related: 15 Marks		**60%**
1	Performing the test / Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related: 10 Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 06: Use of Reynold's apparatus to determine type of flow.

I. Practical Significance

Deciding the type of flow is required to design the conduits. There are different types of flows; Steady, Unsteady, Uniform, Non-uniform, Laminar and turbulent flow etc. In this experiment we will be able to differentiate the laminar and turbulent flow both through observation and calculations.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO3 - Calculate relevant parameters for given fluid flow.

IV. Laboratory Learning Outcome(s)

LLO 6.1 Interpret type of flow based on computed value of Reynold's number

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background

1. In fluid dynamics, laminar flow is a flow in which fluid particles do not cross each other's path. It occurs when a fluid flows in parallel layers, with no disruption between the layers.
2. Turbulent flow is the type of fluid flow in which the fluid particles move in a zigzag manner. In turbulent flow the speed of the fluid at a point is continuously undergoing changes in both magnitude and direction.
3. Reynold's number is a dimensionless number (no units)
4. Reynold's number values is different for open channel and pipe flow.
5. $Re = \rho vD/\mu$ where ρ = mass density, v = velocity of flow, D= diameter the pipe, μ = coefficient of friction

VII. Experimental Set-up

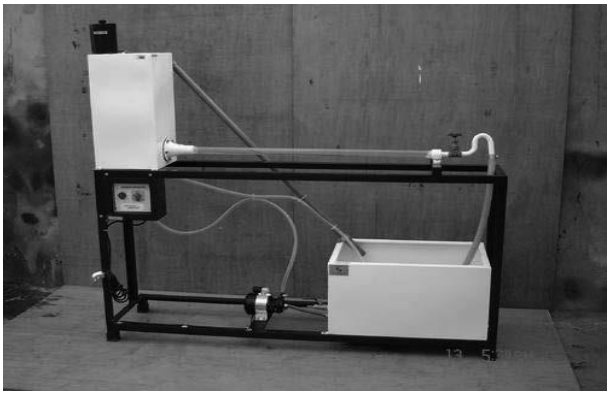

Fig 6. 1. Reynold's Apparatus

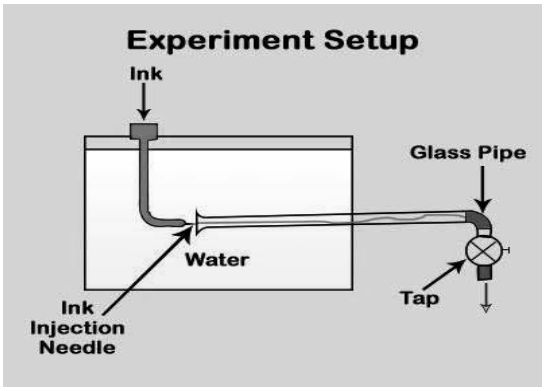

Fig 6.2. Line diagram of set-up

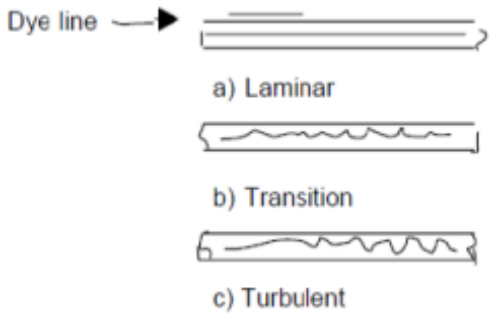

Fig.6.3. Dye line

VIII. Resources required

Sr. No	Particulars	Specification	Quantity	Remark
1	Reynold's apparatus	Standard make	1	For each batch

IX. Procedure

1. Note the diameter of the pipe.
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.
5. Maintain constant level of water by opening both inlet valve.
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, note time of collection of water and compute the discharge.
8. Gradually increase the velocity of flow and measure the discharge.
9. Repeat the readings till dye get dispersed in the flow of water.
10. Repeat the experiment with the varying the rate of flow.

X. Precautions to be followed

1. Use the apparatus carefully.
2. Observe the readings with precision

XI. Observations and Calculations (Use blank sheet provided if space not sufficient)

1. Inner diameter of the glass tube, D =_____m.
2. C/S area of the glass tube =$A=\pi D^2/4$ =_____m^2
3. Mass density of water ρ_w= 1000kg/m^3 = _____
4. Dynamic viscosity of water, μ =_____N.s/m^2.
5. Area of Tank = L x B =_____m^2
6. Name of the dye used =_____

Run no	Volume, m^3	Time (T) sec	Discharge Q= Volume /Time	Velocity, V= Q/A	Re = $\rho VD/\mu$	Type of flow In pipe
1						
2						
3						

Sample calculations

Discharge, Q= Volume / Time

Velocity, V= Q/A

Re= $\rho VD/\mu$

XII. Results

Reynold's number, Re and type of flow,

1.
2.
3.

XIII. Interpretation of results (Give meaning of the above obtained results)

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XIV. Conclusions and Recommendations (if any)

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XV. Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Name the dye used in the experiment.
2. Give two practical examples for laminar and turbulent flow.
3. Name two dyes used in Reynold's experiment.
4. State the values of Reynold's number for laminar, turbulent and transition flowthrough pipes and channels.

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XVI. References / Suggestions for further Reading

Sr. No.	Link	Description
1	https://eerc03-iiith.vlabs.ac.in/exp/reynolds/	Virtual laboratory practical on Reynolds number
2	https://eerc03-iiith.vlabs.ac.in/exp/reynolds/simulation.html	Virtual laboratory practical on Reynolds number
3	https://www.youtube.com/watch?v=upHHx42r4E0	Reynolds Experiment

XVII. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Performing the test / Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10 Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total: 25 Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 7: Use of Bernoulli's apparatus to obtain Total Energy Line for flow in closed conduit of varying cross sections

I. Practical Significance

The significance of Bernoulli's principle can be summarized as total head is constant along a streamline. The sum of potential energy, kinetic energy and pressure energy is constant on every streamline provided no energy enters or leaves the system. This principle is used in various instruments to measure the rate of flow.

II. Industry/Employer Expected Outcomes

Apply the principles of hydraulics in given situation to solve the civil engineering problems.

III. Course Level Learning Outcome(s)

CO3 - Calculate relevant parameters for given fluid flow.

IV. Laboratory Learning Outcome(s)

LLO 7.1 Apply Bernoulli's theorem the given situation to obtain Total Energy Line

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member.

VI. Relevant Theoretical Background:

Bernoulli's theorem states that in an ideal, incompressible fluid, when the flow is steady and continuous, the sum of pressure energy, kinetic energy and potential energy is constant along a stream line.

Potential energy: Potential energy is the energy possessed by the fluid/object because of its position with respect to some arbitrary horizontal datum plane.

The potential energy per unit weight = Z, in metres.

Kinetic energy: It is the energy possessed by a liquid by virtue of its motion. Suppose a liquid of weight W is moving at a velocity V metres/second.
K.E. = ½ mV2

Pressure energy: When the liquid is in motion, it is under some pressure. This pressure is converted into equivalent height of liquid.

$h = P/\gamma L$, γL = being specific weight of liquid.

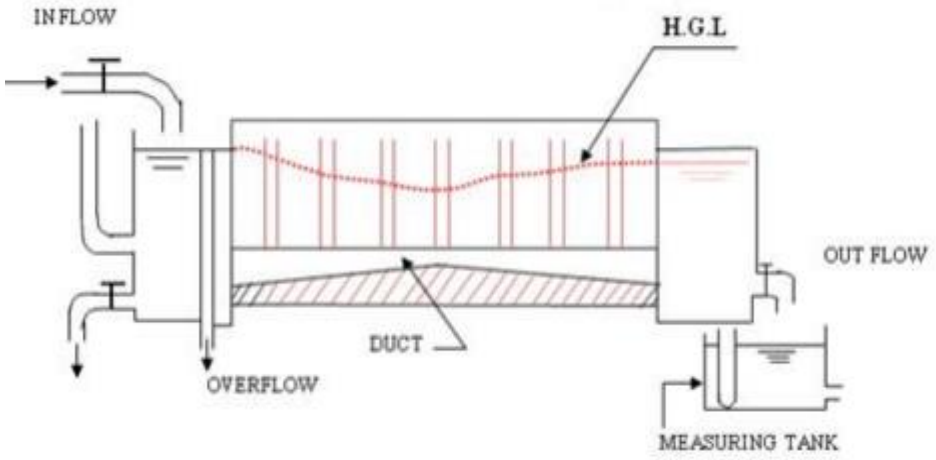


Fig 7.1. Bernoulli's Apparatus

VII. Requires Recourses/Apparatus/Equipment with Specifications

Sr. No	Particulars	Specification	Quantity	Remark
1	Bernoulli's apparatus	Standard make	1	For each batch

VIII. Procedure:

1. Find the area of the measuring tank by measuring length (L) and width (B).
2. Note the area of piezometers at various gauge points.
3. Open the supply valve and adjust the flow so that the water level in the inlet tank remainsconstant.
4. Measure the height of water level in different piezometric tubes.
5. Measure the discharge of conduit with help of measuring tank.
6. Repeat the steps 3 to 5 for two more readings.

7. Plot the graph between the total head and distance of gauge point starting from the upstream side of the conduit.

IX. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Maintain high standards of hygiene.
c. Efficient application of tools, equipment's and machinery.
d. Professional and ethical standards
e. Demonstrate working as a leader/a team member

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

1. Discharge measurement

Area of measuring tank, A= L x B =_____m^2

Time of collection of liquid = T =_____sec

H= Rise in liquid level collected in measuring tank in T sec =_____m

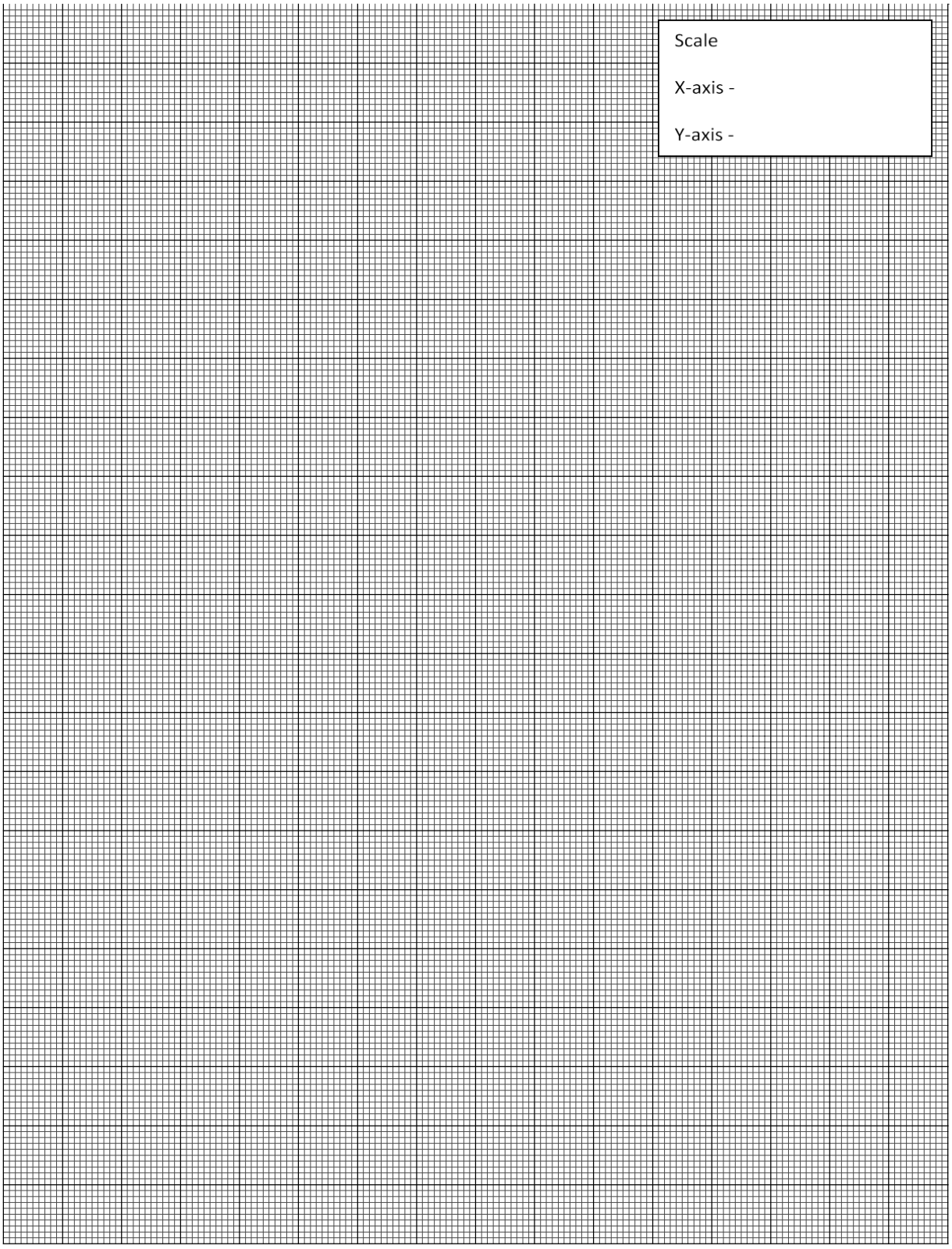
XI. Table for measuring discharge

Run no.	Initial level of water in measuring tank H_1	Final level of water in measuring tank H_2	Rise in level of water in measuring tank $H=H_2-H_1$	Time T	Volume of water Ax H	Discharge Q=Volume/time
Units	In meter	In meter	In meter	sec	m^3	m^3/sec
1						
2						
3						

XII. Table for calculation of total head/ Energy

Piezometer number		1	2	3	4	5	6	7	8	9	10	11
C/S area of pipe												
	Pr Head= p/ γ											
	Velocity, V= Q/A											
	Vel. head = $V^2/2g$											
	Datum head = Z											
	Total head=											

Run no 1	p/ γ + $V^2/2g+Z$											
Run no 2	Pr Head= p/ γ											
	Velocity, V=Q/A											
	Vel. head= $V^2/2g$											
	Datum head= Z											
	Total head= p/ γ + $V^2/2g+Z$											
Run No 3	Pr Head= p/ γ											
	Velocity, V=Q/A											
	Vel head= $V^2/2g$											
	Datum head= Z											
	Total head= p/ γ + $V^2/2g+Z$											


Scale
X-axis -
Y-axis -

XIII. Results

Total head= p/ γ + $V^2/2g+Z$

1. _____ m
2. _____ m
3. _____m

XIV. Interpretation of results (Give meaning of the above obtained results)

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XV. Conclusions and Recommendations (if any)

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XVI. Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Write Bernoulli's formula and give meaning of each term.
2. State the limitations of the Bernoulli's theorem.
3. State the practical applications of the Bernoulli's theorem.
4. State modified Bernoulli's theorem.
5. Draw the graph of pressure energy, kinetic energy and total energy for the observationstaken.

[Space to Write Answers]

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XVII. References / Suggestions for further Reading

Sr. No.	Link	Description
1	https://www.youtube.com/watch?v=hYBCaRdEvjU	Bernoulli's Theorem
2	https://www.youtube.com/watch?v=-jb5A9GIuNQ	Energy gradient line
3	https://eerc03-iiith.vlabs.ac.in/exp/bernoullis/simulation.html	Virtual laboratory practical on Bernoulli's Theorem
4	ttps://eerc03-iiith.vlabs.ac.in/exp/bernoullis/theory.html	Virtual laboratory practical on Bernoulli's Theorem

XVIII. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related: 15 Marks		**60%**
1	Performing the test / Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related: 10 Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total : 25 Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.8: Use of Friction factor apparatus to determine friction factor for a given pipe.

I. Practical Significance

When water is flowing in a pipe, it experiences resistance to its motion whose effect is to reduce the velocity and finally reduces the discharge. It depends upon the roughness of the inside wall of the pipe. This resistance is known as frictional resistance and loss occurred is known as head loss due to friction.

Industry / Employer Expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

II. Course Level Learning Outcome(s)

Determine the loss of head of fluid flow through pipes.

Laboratory learning outcome(s)

LLO 8.1 Determine friction factor for the given pipe using Friction factor Apparatus.

III. Relevant Affective Domain related outcome(s)

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

V. Relevant Theoretical Background

Total energy of fluid flow reduces in the direction of flow. The loss in energy is mainly (major reason of loss) due to friction and some minor losses.

Darcy's Weisbach Equation is used to find the Friction loss in flow through pipes,

$$h_f = \frac{flv^2}{2gD} = \frac{flQ^2}{12.1D^5}$$

Where, f = Darcy's friction factor
l = length of the pipe,
V = velocity of flow,
D = Diameter of the pipe,
Q = Discharge,
g = acceleration due to gravity

VI. Experimental setup

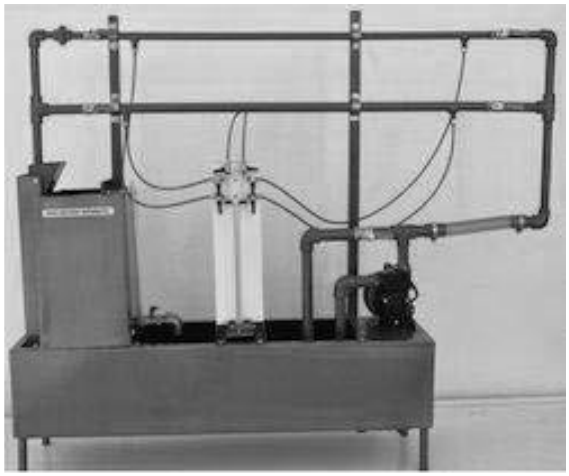

Fig 8.1 Pipe friction factor apparatus

VII. Required Resources/apparatus/equipment with specifications.

Sr. No.	Particulars	Specification	Quantity	Remark
1	Pipe friction factor apparatus	Standard make	1	For each batch

VIII. Precautions to be followed (Safety instructions / Rules / Standards)

1. Use the apparatus carefully.
2. Observe the readings with precision.

IX. Procedure

1. Open the inlet valve and allow the flow to pass through the desired pipe.
2. From overhead tank allow water to flow through desired pipe for 2-3 minutes.
3. Open tapping of manometer on desired pipe.
4. Measure the rise in the level of water in the measuring tank for predetermined time interval and calculate the discharge.
5. Measure the height of mercury column in left as well as right limb of U tube differential manometer. The respective level of mercury in each limb is to be noted in the observation table.
6. Repeat procedure for 3-4 different discharge conditions by operating the inlet valve.
7. Repeat the steps 2-6 for pipes of different diameter by allowing the water to flow through the required pipe line by opening the respective valves.

X. Observation table

1. Material of pipe =_____
2. Area of Measuring tank = L x B =_____m^2
3. Distance between pressure tappings, l, 2 =_____m
4. Specific gravity of fluid in pipe S_1 =_____
5. Specific gravity of fluid in manometer S_2 =_____

Sr. No.	Dia of Pipe, D	Manometer reading			$h_f = x\left(\frac{s_2}{s_1} - 1\right)$	Rise of water in measuring tankin m, H	Time for collecting water in measuring tank, T sec	$Q = \frac{LBH}{T}$	Darcy's friction factor, $f = \frac{12.1 h_f D^5}{l Q^2}$
		x_1	x_2	X= x_1-x_2					
1									
2									
3									

Sample Calculations

$h_f = x\left(\frac{s_2}{s_1} - 1\right)$

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Darcy's factor, $f = \frac{12.1 h_f D^5}{l Q^2}$

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XI. Result(s)

Darcy's friction factor, f=

i. _____

ii. _____

iii. _____

XII. Interpretation of results

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XIII. Conclusion and recommendation

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XIV. Practical related questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the total volume of the tank used for collecting water.
2. State the power of the pump used in the hydraulic bench.
3. State the type of material the pipes are made of.
4. State the capacity of the Sump tank.

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XVIII. References/Suggestions for further reading

Sr. No.	Link	Description
1	https://fm-nitk.vlabs.ac.in/exp/friction-in-pipes/	Friction in Pipe
2	https://www.youtube.com/watch?v=3ebGQi_SH3M	Major Losses

XIX. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.9: Determination of minor losses in pipe for sudden contraction and sudden enlargement.

I. Practical Significance

When fluid flows through pipe, energy losses occur due to various reasons, in the direction of flow. Predominant loss is due to the friction (pipe roughness). The additional Components like inlet, outlet, bend, valves, sudden enlargement and contraction add to the overall head loss of the system resulting in decrease in discharge. While designing pipe line total head loss is required, to be calculated.

II. Industry / Employer Expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. Course Level Learning Outcome(s)

Determine loss of head for flow through pipe in given situation

IV. Laboratory learning outcome(s)

LLO 9.1 Determine minor losses in pipe fittings (sudden contraction and sudden enlargement)

Relevant Affective Domain related outcome(s)

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/ team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

V. Relevant Theoretical Background

When Energy is measured in "meters" is called head. The minor head losses are caused by certain local features or disturbances. The disturbances may be caused in the size or shape of the pipe. This deformation affects the velocity distribution and may result in eddy formation.

Sudden Enlargement: - Two pipes of cross-sectional area A1 and A2 are as shown in Fig 9.1. When the enters the larger section eddies will form resulting in turbulences and causing dissipation of energy.

The loss in head or energy due to sudden enlargement is given by:-

$$h_{enlargement} = \frac{(v_1 - v_2)^2}{2g}$$

Sudden Contraction:- It represents a pipe line in which an abrupt contraction occurs.

The area of flow minimizes a little distance away from actual area of contraction of pipe is known as vena contracta, refer Fig9.2

$$h_{con} = \frac{0.5\, v^2}{2g} h_{con} = (\frac{1}{c_c} - 1)^2 \frac{v^2}{2g}$$

VI. Experimental set up

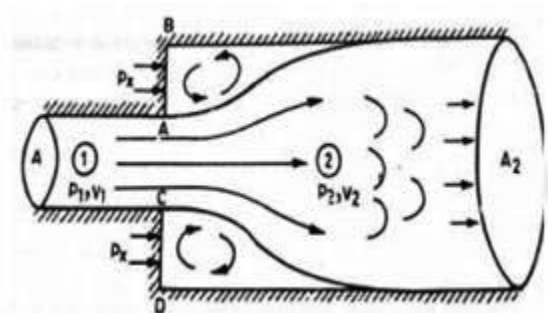

Fig 9.1. Sudden enlargement

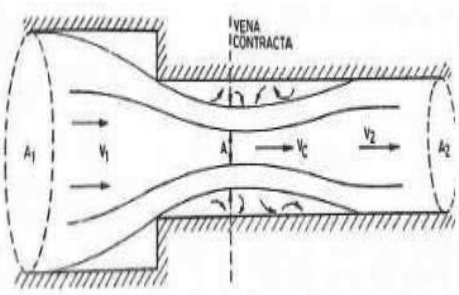

Fig 9.2. Sudden contraction

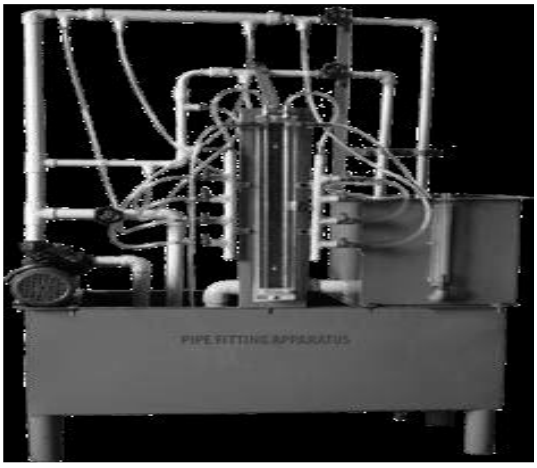

Fig 9.3. Experimental set up

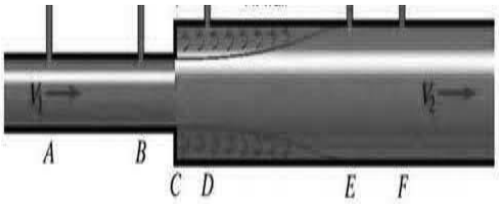

Fig 9.4. Sudden enlargement

VII. Required Resources/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark
1	Pipe of known diameter fitted with Sudden enlargement, sudden contraction.	Standard make	1	For each batch
2	Discharge measuring tank fitted withA scale and piezometer tube	Standard make	1	For each batch
3	U tube differential manometer	Standard make	1	For each batch

VIII. Precautions to be followed (Safety instructions / Rules / Standards)

1. Avoid spilling of water while conducting this experiment.
2. Maintain the adequate pressure by adjusting valve.

3. Take the readings accurately.
4. Handle mercury with care.
5. No air should be trapped in the apparatus system.

IX. Procedure

1. Open the inlet valve, keeping the outlet valve closed.
2. Connect the manometer rubber tubing to one of the pipes/pipe fitting and check that there is no air bubble entrapped.
3. Open partially the outlet valve, keeping the common inlet valve fully open.
4. Allow the flow to get stabilized and then take manometer reading.
5. Measure discharge.
6. Repeat the procedure at least three times.

X. Observation table

Area of Measuring Tank = _____ m^2

Area of large pipe (A_1) = _____ m^2

Area of small pipe (A_2) = _____ m^2

Pipe fitting	**Manometer Reading (for mercury manometer)***				**Discharge measurement**					**Head loss obtain by discharge (calculation)**	**Head loss obtained by manometer reading (Observations Hm)**
Sudden enlarge-ment	h_1	h_2	h = (h_1-h_2)	$H = h(\frac{S_2}{S_1} - 1)$	Volume = area of measuring tank x rise in water level in measuring tank	Time	Q= Volume/time	$V_1 = \frac{Q}{A_1}$	$V_2 = \frac{Q}{A_2}$	$h = \frac{(V_1 - V_2)^2}{2g}$	
1											
2											
3											

Sudden contract -ion										$h_c = \frac{(0.5\ V)^2}{2g}$	
1											
2											
3											

*If manometric liquid is water then use h=H

Sample calculations

For sudden enlargement, $h_{enlargement} = \frac{(V_1 - V_2)^2}{2g}$

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For sudden contraction, $h_{con} = \frac{(0.5\ V)^2}{2g}$

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XI. Result(s)

Average value of head loss in

Sudden enlargement = _____m.

Sudden contraction =_____m.

XII. Interpretation of results

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XIII. Conclusion and recommendation

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XIV. Practical related questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Write the formula for head loss due to sudden enlargement, sudden contraction, and write meaning of each term.
2. Mention the measures taken to reduce minor losses in house plumbing.
3. Describe the variation of minor losses when discharge is increased or decreased by operating regulating valve.

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XV. References/Suggestions for further reading

S. No.	Link	Description
1	https://www.youtube.com/watch?v=6jClbqlGctY	Minor losses
2	https://www.youtube.com/watch?v=hNtQMu57j44	Minor losses in pipe fitting

XVI. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.10: Determination of minor losses in pipe fitting such as Bend and Elbow.

I. Practical Significance

When fluid flow through pipe, energy losses occur due to various reasons, in the direction of flow. Predominant loss is due to the friction (pipe roughness).The additional components like inlet, outlet, bend, valves, sudden enlargement and contraction add to the overall head loss of the system resulting in decrease in discharge. While designing pipe line total head loss is required, to be calculated.

II. Industry / Employer Expected outcome.

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. Course level learning outcome(s).

Determine the loss of head of fluid flow through pipes.

IV. Laboratory learning outcome(s)

LLO 10.1 Calculate minor losses in pipe fitting (Bend and Elbow)..

V. Relevant affective domain related outcome(s)

a. Follow safety practices.

b. Practice good housekeeping.

c. Demonstrate working as a leader/team member.

d. Maintain tools and equipment.

e. Follow ethical practices.

VI. Relevant theoretical background

Minor loss in a bend is due to flow separation on the curved walls and a swirling secondary flow arising from the centripetal acceleration. Since the flow pattern in valves, bends and fittings are quite complex. The losses are usually measured experimentally and correlated with the pipe flow parameters. In turbulent flow, the Minor Loss varies as the square of the velocity.

$$h_m = \frac{kv^2}{2g}$$

Where, h_m=minor loss for a fitting, while calculating head loss due to bend k=coefficient of bend which dependence upon angle of bend, radius of curvature of bend and diameter of pipe, while calculating head loss due to fitting (elbow) k= coefficient which depends upon the type of the pipe fitting. ν =mean velocity of the flow in the pipe. Bends are provided in pipes to change the direction of flow through it.

VII. Experimental set up

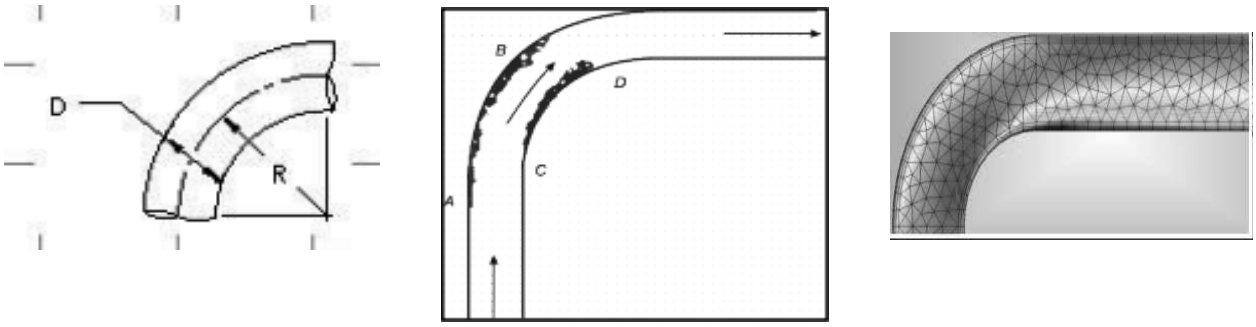

Fig 10.1.Bend

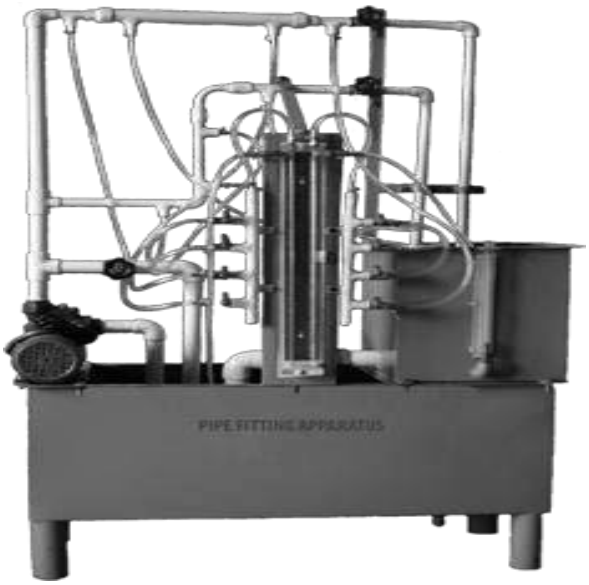

Fig 10.2 Experimental set up

VIII. Required Resources/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark
1	Pipe of known diameter fitted with bent and elbow	Standard make	1	For each batch
2	Discharge measuring tank fitted with a scale and piezometer tube	Standard make	1	For each batch
3	U tube differential manometer	Standard make	1	For each batch

IX. Precautions to be followed.

1. Avoid spilling water while conducting this experiment.
2. Maintain the adequate pressure by adjusting valve.
3. Take the readings accurately.
4. Handle mercury with care.
5. No air should been trapped in the apparatus system.

X. Procedure

1. Open the inlet valve, keeping the outlet valve closed.
2. Connect the manometer rubber tubing to one of the pipes/pipefitting and check that there is no air bubble entrapped.
3. Open partially the outlet valve, keeping the common inlet valve fully open.
4. Allow the flow to get stabilized and then take manometer reading.
5. Measure discharge
6. Repeat the procedure atleast three times.

XI. Observation table

Area of Measuring Tank =_____m^2

Area of large pipe (A_1)= _____m^2

Area of small pipe (A_2) =_____m^2

Pipe fitting	Manometer Reading (for mercury manometer)*				Discharge measurement					Head loss obtain by discharge (calculations)	Head loss obtained by manometer reading (observations)
Pipe bend	h_1	h_2	h = (h_1-h_2)	$H = h(\frac{S_2}{S_1} - 1)$	Volume = area of measuring tank x rise in water level in measuring tank	Time	Q= V/T	$V_1 = \frac{Q}{A_1}$	$V_2 = \frac{Q}{A_2}$	$h_{bend} = \frac{KV^2}{2g}$	
1											
2											
3											

										$h_{elbow} = \frac{KV^2}{2g}$	
Pipe fitting (elbow)											
1											
2											
3											

If manometric liquid is water then use h=H

Sample Calculation.

For bend, $h_{bend} = \frac{KV^2}{2g}$

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For sudden elbow, $h_{elbow} = \frac{KV^2}{2g}$

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XII. Results

Average value of head loss in=

Due to bend=___m.

Due to elbow= __m.

XIII. Interpretation of results

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XIV. Conclusions and Recommendations (if any)

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XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Write the formula for head loss due to bend, elbow, and write meaning of each term.

2. Mention the measures taken to reduce minor losses in house plumbing.

3. Describe the variation of minor losses when discharge is increased or decreased by operating regulating valve**.**

XVI. Space to Write Answers

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XVII. References/Suggestions for further Reading

Sr. No.	Link	Description
1	https://www.youtube.com/watch?v=6jClbqlGctY	Minor losses
2	https://www.youtube.com/watch?v=FW1se5jW8X0	Head Loss Due to Sudden Contraction

XVIII. Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks Obtained			Dated sign of Teacher
Process Related(15)	Product Related(10)	Total (25)	

Practical No. 11: Calibrate the venturimeter to find out the discharge in a pipe.

I. Practical Significance

Venturimeter is a device used to measure the rate of flow that is discharge of a fluid in a pipe. A Venturimeter may also be used to increase the velocity of any type of fluid in a pipe at any particular point. This device is permanently fixed in a pipe line. The calibrated Venturimeter can be used to measure discharge, wherever required.

II. Industry/employer expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. Course level learning outcome(s)

Determine loss of head for flow through pipe in given situation.

IV. Laboratory learning outcome(s)

LLO 11.1 Determine the Coefficient of discharge for the given venturimeter fitted in pipe section.

V. Relevant affective domain related outcome(s)

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

VI Relevant theoretical background

Venturimeter is the practical application of Bernoulli's theorem. When a venturimeter is placed in a pipe carrying the fluid whose flow rate is to be measured, a pressure drop occurs from the convergent cone to the throat of the venturimeter.

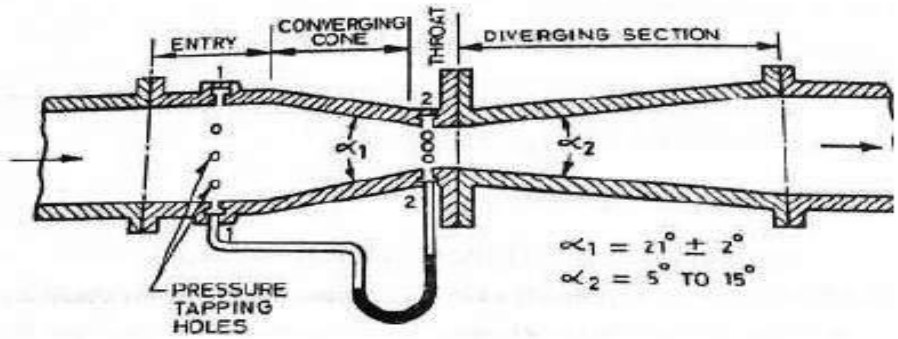

Fig 11.1 C/S of Venturimeter

Coefficient of discharge is the ratio of actual discharge to the theoretical discharge. Actual discharge is always less than theoretical discharge because of major and minor losses.

$$C_d = \frac{Q_{ACTUAL}}{Q_{THEORETICAL}}$$

VII. Experimental set up

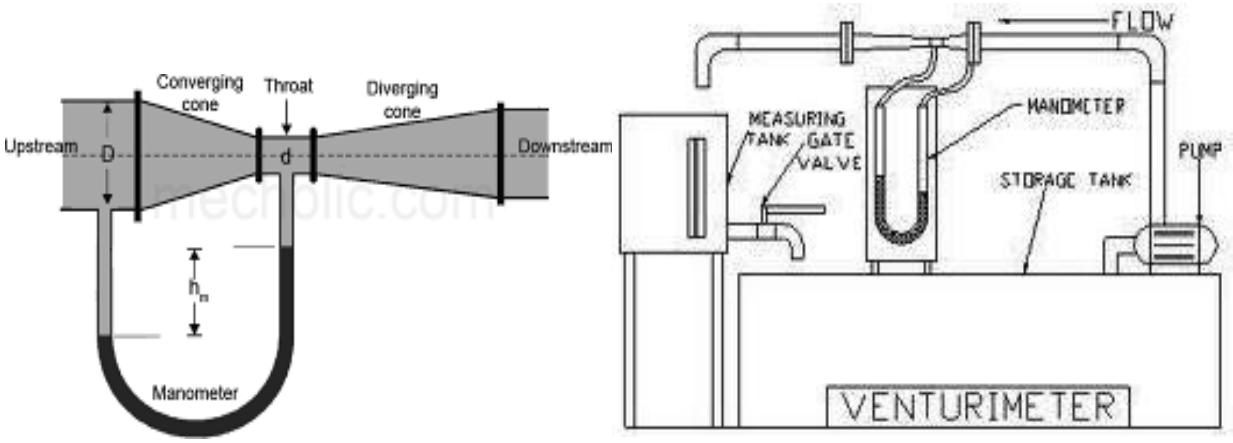

Fig No10.2 .Venturimeter

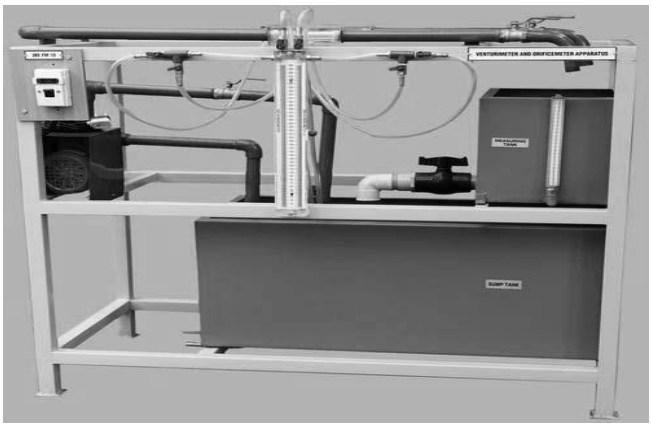

Fig.No 10.3 Experimental set up

VIII. Required resource/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark (Photos)
1	Venturimeter fitted on pipeline	Standard make	1	For each batch
2	Discharge measuring tank fitted with A scale and piezometer tube	Standard make	1	For each batch
3	U-tube differential manometer	Standard make	1	For each batch

IX. Precautions to be followed (Safety instructions/rules/standards).

1. Measure the discharge carefully.

2. Use the apparatus carefully.
3. Observe the readings with precision.
4. Remove air bubble from manometer.
5. Maintain constant discharge before taking reading.

X. Procedure

1. Open the inlet regulating valve so that water starts flowing through the venturimeter.
2. Wait for sometime so that flow gets steady.
3. Remove air bubbles if any entrapped, in piezometric tubes or U-tube differential manometer.
4. Note differential manometric reading h.
5. Measure the discharge by collecting a certain volume of water in measuring tank in predetermined time.
6. Repeat the procedure at least three times.

XI. Observation table

Area of Measuring Tank= m^2

Diameter of large pipe(D)=m

Areaof large pipe(A)=$\frac{\pi D^2}{4}$= m^2

Diameter of small pipe (d)=m

Area of large pipe (A)= $\frac{\pi d^2}{4}$= m^2

SN	Rise of water level in measuring tank (H)m	Volume of water collected V=A *H	Time T sec	Discharge Q actual = Volume/T m^3/s	Difference of manometric liquid between two limbs		Therotical discharged formula =Q_{th}	Coefficent of discharge $C_d = \frac{Q_{act}}{Q_{th}}$	Average C_d
					Diff h_m (m)	$\Delta h = h_m(\frac{S_2}{S_1} - 1)$			
1									
2									
3									
4									

Sample calculations:

$$Q_{act} = \frac{Vol.\,of\ water\ collected\ in\ the\ tank}{Time}$$

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$$Q_{th} = \frac{A_a}{\sqrt{A^2 - a^2}}\sqrt{2g\Delta h}$$

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$$C_d = \frac{Q_{ACTUAL}}{Q_{THEOROTICAL}}$$

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XII. Results

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XIII. Interpretation of results

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XIV. Conclusions and Recommendations(ifany)

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XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Name or identify the parts of venturimeter where maximum velocity of flow will occur.
2. Pressure at the throat of venturimeter is minimum. Give reason.
3. In venturimeter, length of divergent cone is always greater than convergent cone. Give reason.
4. Is it possible to use venturimeter for measuring discharge in an open channel?
5. Define coefficient of discharge? State the unit.
6. State the use of measuring tank?
7. State the sequential steps to calculate the actual discharge.
8. Theoretical discharge is always greater than actual discharge. Give reason.
9. Give the practical situations where the concept/Principle of venturimeter isused.

Space to Write Answers

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XVI. References/Suggestions for further Reading: Include website/links/virtual lab link.

Sr. No.	Link	Description
1	https://fmnitk.vlabs.ac.in/exp/venturimeter/simulation.html	Use of venturimeter
2	https://www.youtube.com/watch?v=UNBWI6MV_lY	Use of venturimeter

XVII. Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks obtained			Dated sign of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No.12: Calibration of the orifice to find out the discharge through a tank.

I. Practical Significance

An orifice is an opening in the wall or base of a vessel through which fluid flows. The top edge of orifice is always below the free liquid surface. The water is allowed to flow through an orifice under a constant head 'H'. Fluid is discharged in the form of a jet of flow.

II. Industry/employer expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. Course level learning outcome(s):

Find the fluid flow parameters in open channels.

IV. Laboratory learning outcome(s):

LLO 12.1 Calculate Cd, Cc and Cv for given type of Orifice

V. Relevant affective domain related outcome(s):

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/team member.
d. Maintain tools and equipment.

VI Relevant theoretical background:

Orifice is an opening of any cross section such as circular, triangular, rectangular, on a side or on the bottom of the tank, through which a fluid flows. Orifices are used for measuring the rate of flow. It may be observed that liquid approaching the orifice is gradually converges towards orifice, to form a jet whose c/s area is less than that of the orifice, known as vena contracta. The discharge will depend up on the head of the fluid (H) above the level of the orifice.

VII Experimental set up

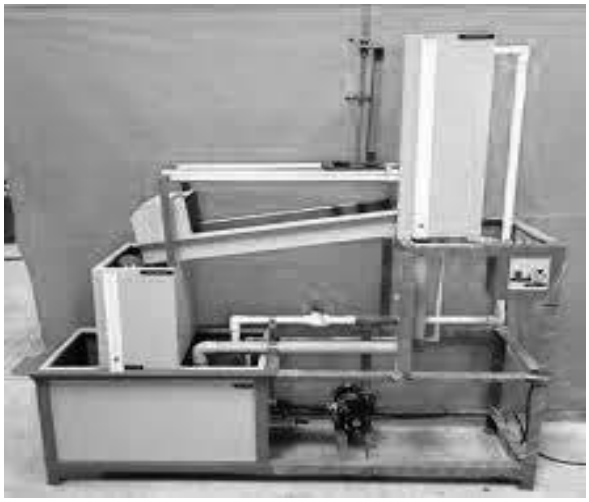

Fig12.1Orifice Experimental Set Up

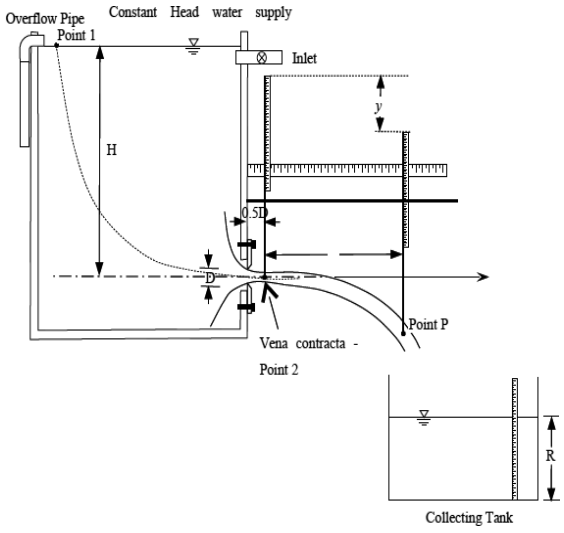

Fig 12.2 Orifice Experimental SetUp

VIII. Required resource/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark
1	Supply tank with piezometer	Standard make	1	For each batch
2	Discharge measuring tank fitted With a scale and piezometer tube	Standard make	1	For each batch
3	Vernier Caliper	Standard make	1	For each batch
4	Stopwatch	Standard make	1	For each batch

IX. Precautions to be followed (Safety instructions/Rules/Standards):

1. Avoid spilling water while conducting this experiment.
2. Maintain the adequate head in intake tank.
3. Take the readings accurately.

X. Procedure

1. Connect the desired size and shape of orifice to the opening in the side wall of the intake tank.
2. Allow water to intake tank through the regulating valve and wait till the water level in the tank becomes steady.
3. Measure the head using the piezometric tube fixed to the intake tank. Measure the discharge corresponding to each value of H.
4. Take minimum three readings.
5. Measure X and Y co-ordinates of the lower surface of the jet trajectory at four different points (origin to be taken at lowest point of the jet at vena contracta).

XI. Observation table:

Shape of orifice=

Diameter of orifice=__m

Cross sectional area of orifice(a)=___m^2

Cross sectional area of measuring tank(A)=_m^2

ΔH=rise in water level in measuring tank=__m.

Sr. No.	ΔH	t	$Q_{ac} = \frac{A\ x\ \Delta H}{t}$ cm^3/s	Constant head at inlet H Cm	$Q_{ac} = a\sqrt{2gH}$	Xcm	YCm	$C_c = \frac{Q_{ac}}{Q_{th}}$	Mean C_d
1									
2									

3									
4									

Sr.No	$C_v = \sqrt{\frac{X^2}{4yH}}$	Mean C_v	$C_C = \frac{C_d}{C_v}$	Mean C_c
1				
2				
3				
4				

Sample Calculations

$$C_d = \frac{Q_{actual}}{a\sqrt{2gH}}$$

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$$C_C = \frac{C_d}{C_v}$$

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$$C_v = \sqrt{\frac{X^2}{4yH}}$$

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XII. **Results:**

The hydraulic coefficients of orifice

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XIII. Interpretation of results:

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XIV. Conclusions and Recommendations:

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XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design moresuchquestionssoastoensuretheachievementofidentifiedCO.Writeanswersofmini mumthreequestions.

1. State the formula for determination of theoretical discharge, and write meaning of each term.
2. Define coefficient of discharge, coefficient of velocity, contraction. State relation between them.
3. State the stepwise procedure to measure the actual discharge.
4. Constant head is to be maintained in the tank, while taking the reading. Give reason.

Space to Write Answers

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XVI. References/Suggestions for further Reading

Sr. No.	Link	Description
1	https://eerc03-iiith.vlabs.ac.in/exp/orifices/	Experiment of Flow through orifice.
2	https://www.youtube.com/watch?v=qZM5Voq37CA	Experiment of Flow through orifice.

XVII. Assessment Scheme

Performance Indicators		Weightage(%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No.13: Determination of efficiency of given centrifugal pump

I. Practical Significance:

Centrifugal pumps are used to transport all (viscous) type of fluids. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. Common uses of the centrifugal pump include lifting of water, sewage, paper pulp, petroleum and petrochemical pumping.

Industry / Employer Expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

II. Course Level Learning Outcome(s)

Select relevant hydraulic pumps for different applications.

III. Laboratory learning outcome(s)

LLO 13.1 Calculate the efficiency of given Centrifugal Pump.

IV. Relevant Affective Domain related outcome(s)

1. Follow safety practices.
2. Demonstrate working as a leader/team member.
3. Maintain tools and equipment.

V. Relevant Theoretical Background

Centrifugal pumps are classified as rotodynamic type of pumps in which dynamic pressure is developed which enable the lifting of viscous liquids from lower to higher level

The basic principle on which a centrifugal pump works is that when a certain mass of liquid is made to rotate by an external force, it is thrown away from the central axis of rotation .and a centrifugal head is impressed which enables it to rise to a higher level.

$$Overall\ efficiency = \frac{wQH_m}{input\ power} x100\%$$

Where, w = Specific weight of liquid to be lifted N/ m^3.

Q = Discharge of pump m^3/sec

H_m = Manometric Head m

Input power =. Power of the given pump

VI. Experimental set up

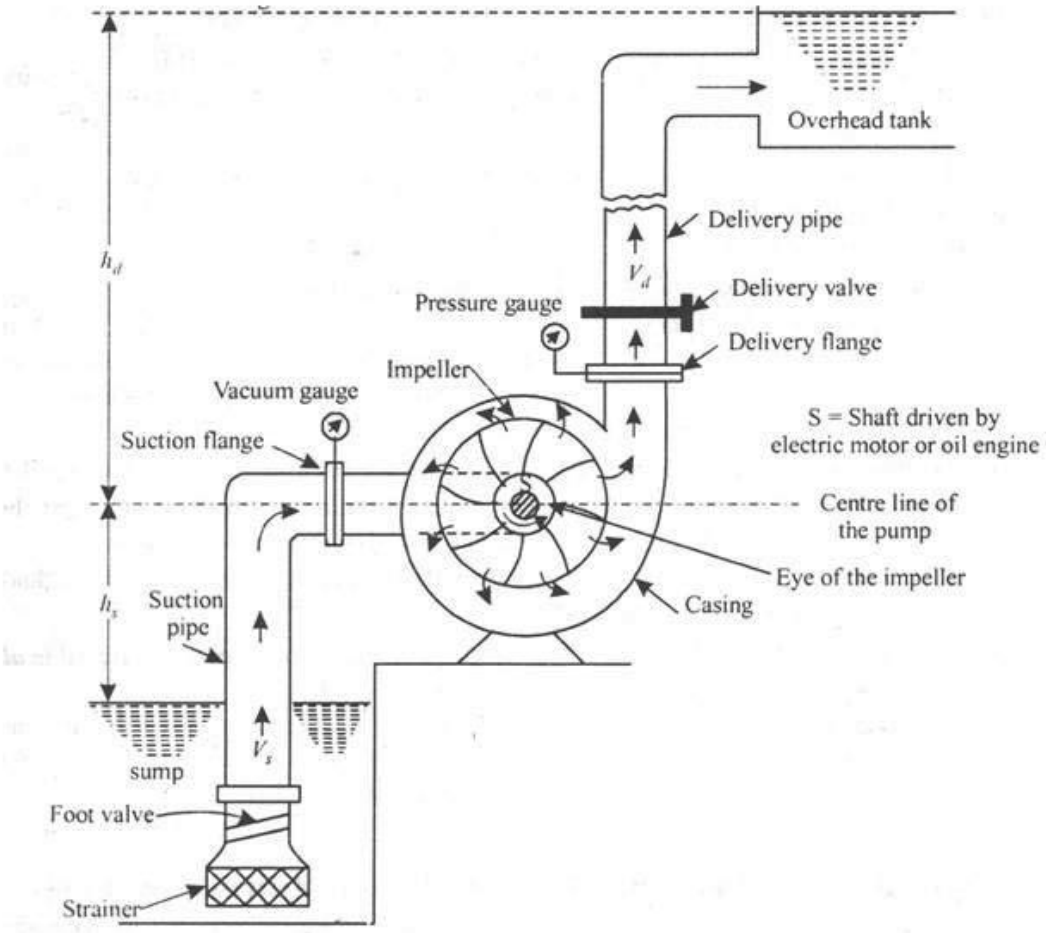

Fig 13.1 Component parts of Centrifugal Pump

VII. Required Resources/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark
1	Centrifugal pump with motor	Standard make	1	For each batch
2	Stopwatch	Standard make	1	For each batch
3	Pressure gauge	Standard make	1	For each batch

VIII. Precautions to be followed (Safety instructions / Rules / Standards)

1. Printing should be done before starting the pump.
2. Open all valves completely and never shut down delivery valves
3. See that foot valve in water tank drain all tanks after the experiment.
4. Shut off the system completely.

IX. Procedure

1. Switch ON the pump.
2. Collect the discharge of liquid in measuring tank and measure rise in height of water level in T second .
3. Observe and record the suction and delivery pressure indicated by pressure gauges at suction and delivery pipe respectively.
4. Note down the readings measuring tank.
5. Repeat the procedure for a three reading.

X. Observation table

Sr.No	Rise in water level In tank 'h'	Time of water Collection in Tank 'T'	Discharge Q=Ax h/T	Total Head Hm
1				
2				
3				

Sample Calculation

$Overall\ efficiency = \frac{wQH_m}{input\ power} x100\%$

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XI. Result(s)

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XII. Interpretation of results

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XIII. Conclusion and recommendation

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XIV. Practical related questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Write specifications pump used in this experiment.
2. Define priming of a pump and state its necessity.
3. For lifting sewage water which type of pump will be suitable and why?
4. Differentiate reciprocating and centrifugal pump.
5. State sequential steps of the working/operation of centrifugal pump.
6. State the make of centrifugal and reciprocating pump used in laboratory.
7. State the practical/day to day life situations where reciprocating pump is used.
8. Length of suction pipe is always less than delivery pipe? Give reason.

Space to write Answer

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References/Suggestions for further reading

Sr. No.	Link	Description
1	https://www.youtube.com/watch?v=pRUUWb77Sr0	Centrifugal pump experiment
2	https://www.youtube.com/watch?v=DzcFs__C9wU&list=PLiGNmnbK1ts2SrgC6hWZ6nIgBSWbTfkpQ	Main parts of centrifugal pump

Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25 Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 14: Use of 'V' notch to measure the discharge through open channel

I. Practical Significance

Notch is used to measure rate of flow in an open channel. Notch may be defined as opening provided in the side of tank or vessel such that the liquid surface in the tank is below the top edge of the opening. A notch may be regarded as an orifice with the water surface below it supper edge. It is used for measuring the rate of flow of a liquid through a small channel or a tank.

The main difference between a notch and weir is that the notch is of small size but the weir is of bigger one. More over a notch is usually made in a plate whereas a weir is usually made of masonry or concrete.

II. Industry / Employer Expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. Course Level LearningOutcome(s)

Find the fluid flow parameters in open channels.

IV. Laboratory learning outcome(s)

LLO 14.1 Determine the Coefficient of discharge for given 'V' notch fitted to open channel..

V. Relevant Affective Domain related outcome(s)

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/ team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

VI. Relevant Theoretical Background

A Notch is a device used for measuring the rate of flow of a liquid through a small channel or a tank. It may be defined as an opening in the side of a tank or a small channel in such a way that the free liquid surface is always below sill or edge of an opening. Consider a rectangular notch provided in channel or tank carrying water.

The triangular or V notch is advantageously used to measure (low discharge) the accurate discharge with lower head, over the crest.

$$Q = \frac{8}{15} X \sqrt{2g} \tan\frac{\emptyset}{2} H^{\frac{5}{2}}$$

VII. Experimental set up

Fig 14.1Tringular Notch

Fig14.2Tringular Notch

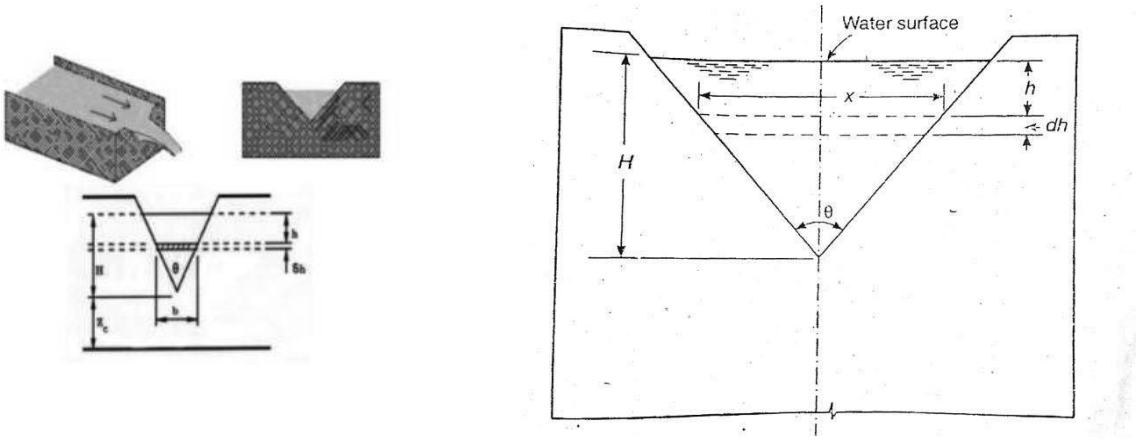

Fig 14.3 Triangular Notch

VIII. Required Resources/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark
1	Notch	Standard make	1	For each batch
2	Discharge measuring tank fitted with a scale and piezometer tube	Standard make	1	For each batch
3	Stopwatch	Standard make	1	For each batch

IX. Precautions to be followed (Safety instructions / Rules / Standards)

1. Reading must be taken in steady or near steady conditions.
2. Discharge must be varied vary gradually from a higher value to smaller values.
3. Maintain steady and continuous flow over the notch.

X. Procedure

1. Select desired size of triangular notch.
2. Measure angle of triangular notch.

3. Measure the sill level.
4. Record three different readings for three different heads over triangular notch by regulating the flow and measure the actual discharge.

XI. Observation table

Sr. No.	Initial Level of water in measuring tank h_1	Final level of water in measuring tank in T sec h = h_1-h_2	Time T sec	Actual Discharge Qact= Ax h/T	Angle of v notch	Head over notch H m	Theoretical Discharge by formula	$C_d = \frac{Q_{act}}{Q_{th}}$	Avg C_d
1									
2									
3									

Sample Calculation

Area of measuring tank (A) = _____m^2 .

Actual Discharge= Q_{act} = A x h/ T =_____m^3/sec.

Theoretical Discharge

$$Q = \frac{8}{15} X \sqrt{2g} \tan\frac{\emptyset}{2} H^{\frac{5}{2}}$$

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XII. Result(s)

Coefficient of discharge through open channel using triangular notch is =

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XIII. Interpretation of results

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XIV. Conclusion and recommendation

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XV. Practical related questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the formula to calculate discharge over triangular notch. State meaning of each term.
2. State the situations when orifice gets converted into notch.
3. Is the Coefficient of discharge a constant for all notches?
4. State the difference between weir and the notch.

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XVI. References/Suggestions for further reading

Sr. No.	Link	Description
1	https://fm-nitk.vlabs.ac.in/exp/calibration-of-v-notch/	Calibration of V Notch
2	https://www.youtube.com/watch?v=SNnQfrTzL8I	Use of V Notch

XVII. Assessment Scheme

Performance Indicators		Weightage(%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.15: Use of rectangular notch to measure discharge through open channel.

I. Practical Significance:

Notch is generally used to measure rate of flow in an open channel flow.

II. Industry / Employer Expected outcome(s)

Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. Course Level Learning Outcome(s)

Find the fluid flow parameters in open channels.

IV. Laboratory learning outcome(s)

LLO 15.1 Determine the Coefficient of discharge for flow through open channel using rectangular notch.

V. Relevant Affective Domain related outcome(s)

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/ team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

VI. Relevant Theoretical Background

Rectangular Notch is used to find discharge. Discharge is calculated by formula

$$Q_{th} = \frac{2}{3} \times L \sqrt{2g}\, H^{\frac{3}{2}}$$

VII. Experimental set up

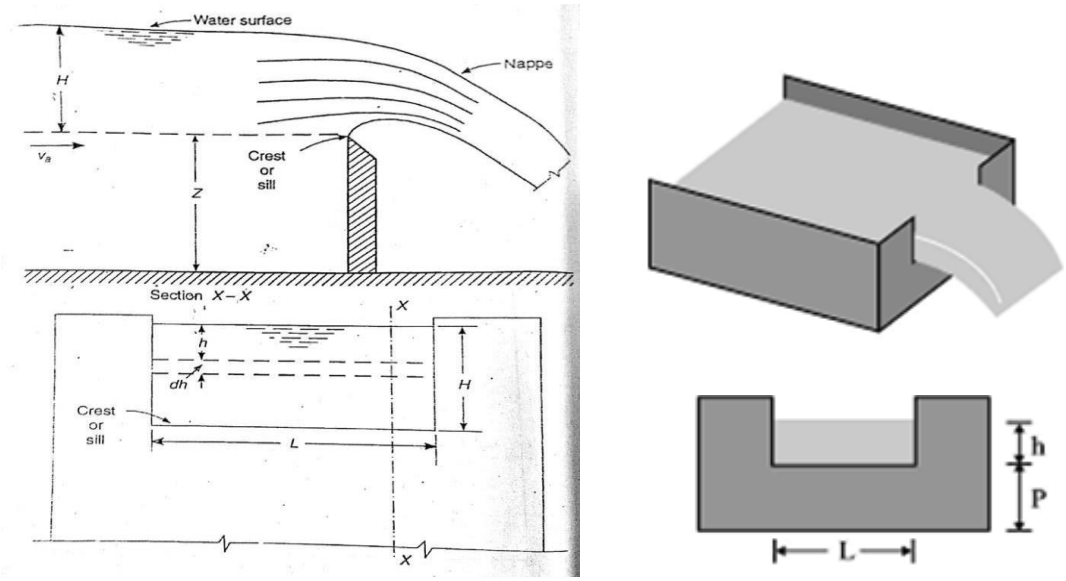

Fig 15.1 Rectangular notch

VIII. Required Resources/apparatus/equipment with specifications

Sr. No.	Particulars	Specification	Quantity	Remark
1	Notch	Standard make	1	For each batch
2	Discharge measuring tank fitted with a scale and piezometer tube	Standard make	1	For each batch
3	Stopwatch	Standard make	1	For each batch

IX. Precautions to be followed (Safety instructions / Rules / Standards)

1. Reading must be taken in steady or near steady conditions.
2. Discharge must be varied vary gradually from a higher value to smaller values.
3. Maintain steady and continuous flow over the notch.

X. Procedure

1. Select desired size of rectangular notch.
2. Measure dimensions of rectangular notch.
3. Establish the zero-hook gauge reading corresponding to the level of the crest of the notch or take initial reading at crest.
4. Record three readings for head over triangular notch by regulating the flow and measure discharge.

XI. Observation table

Sr. No.	Initial Level of water in measuring tank h_1	Final level of water in measuring tank in T sec h = h_1-h_2	Time T sec	Actual Discharge Qact= Ax h/T	Length of rectangular notch	Head over notch H m	Theorotical Discharge by formula	$C_d = \frac{Q_{act}}{Q_{th}}$	Avg C_d
1									
2									
3									

*If manometric liquid is water then use h=H

Sample calculations

Area of measuring tank(A) = _____m^2 .

Actual Discharge= Q_{act} = A x h/ T =_____m^3/sec.

Theoretical Discharge$C_d = \frac{Q_{act}}{Q_{th}}$

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XII. Result(s)

Coefficient of discharge through open channel using rectangular notch is =

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XIII. Interpretation of results

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XIV. Conclusion and recommendation

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XV. Practical related questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the formula for discharge for rectangular notch. Write meaning of each term.
2. State the advantages of triangular notch over rectangular notch.
3. Classify notches according to shape of opening.

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XVI. References/Suggestions for further reading

Sr. No.	Link	Description
1	https://fm-nitk.vlabs.ac.in/exp/calibration-rectangular-notch/videos.html	Calibration of rectangular notch
2	https://www.youtube.com/watch?v=THJpztAOhyg	Use of rectangular notch

XVII. Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15Marks		**60%**
1	Performing the test/Practical accurately	20%
2	Noting down the observations	30%
3	Working in team	10%
Product related:10Marks		**40%**
4	Conclusions	20%
5	Answer to practical related questions	10%
6	Submission of report in time	10%
Total:25Marks		**100%**

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	