LABORATORY MANUAL

B.Tech. Semester- IV

FLUID MECHANICS
Subject code: LC-ME-216G

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DEPARTMENT OF ROBOTICS AND AUTOMATION
DRONACHARYA COLLEGE OF ENGINEERING
KHENTAWAS, FARRUKH NAGAR, GURUGRAM (HARYANA)

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Vision and Mission of the Institute

Vision:

To impart Quality Education, to give an enviable growth to seekers of learning, to groom them as World Class Engineers and managers competent to match the expending expectations of the Corporate World has been ever enlarging vision extending to new horizons of Dronacharya College of Engineering.

Mission:

1. To prepare students for full and ethical participation in a diverse society and encourage lifelong learning by following the principle of 'Shiksha evam Sahayata' i.e. Education & Help.

2. To impart high-quality education, knowledge and technology through rigorous academic programs, cutting-edge research, & Industry collaborations, with a focus on producing engineers& managers who are socially responsible, globally aware, & equipped to address complex challenges.

3. Educate students in the best practices of the field as well as integrate the latest research into the academics.

4. Provide quality learning experiences through effective classroom practices, innovative teaching practices and opportunities for meaningful interactions between students and faculty.

5. To devise and implement programmes of education in technology that are relevant to the changing needs of society, in terms of breadth of diversity and depth of specialization.

Vision and Mission of the Mechanical Department

Vision:

"To become a Centre of Excellence in teaching and research in the field of Mechanical Engineering for producing skilled professionals having a zeal to serve society."

Mission:

M1: To create an environment where students can be equipped with strong fundamental concepts, various experiments and problem solving skills.

M2: To provide an exposure to emerging technologies by providing hands on experience for generating competent professionals.

M3: To promote Research and Development in the frontier areas of Mechanical Engineering and encourage students for pursuing higher education

M4: To inculcate in students ethics, professional values, team work and leadership skills.

Programme Educational Objectives (PEOs)

PEO 1: Engineers will practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams.

PEO 2: Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, and an ability to engage in continuing professional development and life-long learning.

PEO 3: Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects affect society and the environment.

PEO 4: Promote Design, Research, and implementation of products and services in the field of Engineering through Strong Communication and Entrepreneurial Skills.

PEO 5: Re-learn and innovate in ever-changing global economic and technological environments of the 21st century.

Programme Outcomes (POs)

Over completion of the Course our graduates will have ability to

1. Apply knowledge of computing, mathematical foundations, algorithmic principles, and engineering theory in the modeling and design of systems to real-world problems (fundamental engineering analysis skills).
2. Apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.
3. Design and conduct experiments, as well as to analyze and interpret data (information retrieval skills). Practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills.
4. Analyze a problem, identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution(engineering problem solving skills).
5. Understand the appropriate codes of practice and industry standards.
6. Identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques.
7. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues.
8. Communicate effectively, both in writing and orally (speaking / writing skills).
9. Understand professional, ethical, legal, security and social issues and responsibilities (professional integrity).
10. Understand customer and user needs and the importance of considerations such as Aesthetics.
11. Use creativity to establish innovative solutions.
12. Adapt to a rapidly changing environment by having learned and applied new skills and new technologies.
13. To Significantly contribute to delivery of desired component, product, or process.
14. Formulate and solve moderately complex engineering problems, accounting for hardware/software/human interactions.
15. Recognize the importance of professional development by pursuing postgraduate studies or face competitive examinations that offer challenging and rewarding careers in computing.
16. Apply the Knowledge of management techniques which may be used to achieve engineering Objectives within that context.

Program Specific Outcomes (PSOs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following:

PSO1: Apply the knowledge gained in Mechanical Engineering for design and development and manufacture of engineering systems.

PSO2: Apply the knowledge acquired to investigate research-oriented problems in mechanical engineering with due consideration for environmental and social impacts

PSO3: Use the engineering analysis and data management tools for effective management of multidisciplinary projects.

University Syllabus

List of Experiments:

1. To determine the coefficient of impact for vanes.
2. To determine coefficient of discharge of an orificemeter.
3. To determine the coefficient of discharge of Notch (V and Rectangular types).
4. To determine the friction factor for the pipes.
5. To determine the coefficient of discharge of venturimeter.
6. To determine the coefficient of discharge, contraction & velocity of an orifice.
7. To verify the Bernoullis Theorem.
8. To find critical Reynolds number for a pipe flow.
9. To determine the meta-centric height of a floating body.
10. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
11. To show the velocity and pressure variation with radius in a forced vertex flow.
12. To verify the momentum equation.

Note: 1. At least eight experiments are to be performed in the semester

Course Outcomes (COs)

At the end of the course, the student shall be able to:

CO216.1. Understand the techniques and concept of stability.

CO216.2. Learning continuity and Bernoulli's equation.

CO216.3. Analyse discharge measuring devices and hydraulic coefficients.

CO216.4. Knowledge of different types of pipe losses and determine the velocity profile in a pipe.

CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16
C216.1	3	3	3	-	2	-	3	3	3	2	-	3	3	-	-	3
C216.2	-	3	-	-	2	3	-	-		2	-	3	-	-	2	3
C216.3	-	-	3	3		3	-	-	3	-	3	-	3	3	-	
C216.4	3	-	3	-	2	-	3	3	-	2	-	3	-	3	2	3
C216	3	3	-	3	-	3	-	-	3	2	3	-	3	3	-	3

CO-PSO Mapping

	PSO1	PSO2	PSO3
C216.1	3	2	-
C216.2	2	3	-
C216.3	3	2	-
C216.4	3	2	3

Course Overview

Fluid mechanics is an exciting and fascinating subject with unlimited practical applications ranging from microscopic biological systems to automobiles, airplanes, and spacecraft propulsion. Fluid mechanics has also historically been one of the most challenging subjects for undergraduate students because proper analysis of fluid mechanics problems requires not only knowledge of the concepts but also physical intuition and experience

LIST OF THE EXPERIMENT

SNO	NAME OF THE EXPERIMENT	COs
1.	To determine the coefficient of impact for vanes.	CO216.2
2.	To determine the coefficient of discharge of an Orifice Meter.	CO216.3
3.	To determine the coefficient of discharge of Notch (V, Rectangular&Trapezoidal types).	CO216.3
4.	To determine the friction factor for the pipes.	CO216.4
5.	To determine the coefficient of discharge of Venturimeter.	CO216.2
6.	To determine the coefficient of discharge, contraction & velocity of anorifice.	CO216.3
7.	To verify the Bernoulli's Theorem.	CO216.3
8.	To find critical Reynolds number for a pipe flow.	CO216.3
9.	To determine the Meta- centric height of a floating body.	CO216.3
10.	To determine the miner losses due to sudden enlargement, suddencontraction and bends.	CO216.3

DOs and DON'Ts

DOs

1. Work deliberately and carefully.
2. Keep your work area clean.
3. Students must wear college uniform and carry their college ID.
4. Students should have separate note book for practical.
5. Students should have their own pencil, eraser, scale, along with pen and lab note book.
6. Handle the equipment /models carefully.

DON'Ts

1. Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
2. Do not eat food, drink beverages or chew gum in the laboratory.
3. Do not open any irrelevant internet sites on lab computer.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth, if possible, isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.

Emergency: Reception

Security : Main Gate

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows:

1) All files must contain a title page followed by an index page. The files will not be signed by the faculty without an entry in the index page.

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment

(ii) Pre-experiment work (as given by the faculty)

(iii) Lab assignment questions and their solutions

(iv) Test Cases (if applicable to the course)

(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.
2. Students must ensure that their lab record is regularly evaluated.

Lab assessment criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes areassessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

GradingCriteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Pre-Lab written work (this may be assessed through viva)	Complete procedure with underlined concept is properly written	Underlined conceptis written but procedure is incomplete	Not able to writeconcept and procedure	Underlined concept is not clearly understood
AC2: Manual Writing/ Modeling	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/tools are applied, Program/solution written is readable	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied	Assigned problem is properly analyzed &correct solution designed	Assigned problem is properly analyzed and corrected
AC3: Identification & Removal of errors	Able to identify errors and remove them	Able to identify errors/and remove them with little bit of guidance	Is dependent totallyon someone for identification of errors and their removal	Unable to understand the reason for errors even after they are explicitly pointed out
AC4:Execution & Demonstration	All variants of input /output are tested,Solution is well demonstrated and implemented concept is clearlyexplained	All variants of input /output are not tested, However, solution is well demonstrated and implemented concept is clearly explained	Only few variants of input /output are tested, Solution is well demonstrated but implemented concept is not clearly explained	Solution is not well demonstrated and implemented concept is not clearly explained

AC5:Lab Record Assessment	All assigned problems are well recorded with objective, design constructs and solution along with Performance analysis using all variants of input and output	More than 70 % ofthe assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants ofinput and output	Less than 70 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output	Less than 40 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants ofinput and output

EXPERIMENT NO 1

Aim:- To determine the co efficient of impact for vanes.

Apparatus Used:- Collecting tank, Transparent cylinder, Two nozzles of dia 10 mm & 12mm, Vane of different shape (flat, inclined or curved)

Theory:- Momentum equation is based on Newton's second law of motion which states That the algebraic sum of external forces applied to control volume of fluid in any. Direction is equal to the rate of change of momentum in that direction. The external Forces include the component of the weight of the fluid & of the forces exerted externally Upon the boundary surface of the control volume. If a vertical water jet moving with Velocity is made to strike a target, which is free to move in the vertical direction then a Will be exerted on the target by the impact of jet, according to momentum equation this (Which is also equal to the force required to bring back the target in its original position?)

Must be equal to the rate of change of momentum of the jet flow in that direction.

Formula Used:-

$F' = \rho\ Q\ v\ (1-\cos\beta)$

$F' = \rho\ Q^2\ (1-\cos\beta)$ as $v = Q/a$

Where F' =force (calculated)

ρ = density of water

β=angle of difference vane

V =velocity of jet angle

Q =discharge

A =area of nozzle ($\pi/4d^2$)

(i) for flat vane $\beta=90^o$

$F = \rho Q^2/a$

(ii) for hemispherical vane $\beta=180^o$

for % error =F- F'/ F'x100

$F = 2\ \rho Q^2/a$

F = Force (due to putting of weight)

(iii) for inclined vane

$F' = \rho\ Q\ v(1-\cos\beta)$

$F' = \rho\ Q^2\ (1-\cos\beta)$

Procedure:-

1. Note down the relevant dimension or area of collecting tank, dia of nozzle, and density of water.
2. Install any type of vane i.e. flat, inclined or curved.
3. Install any size of nozzle i.e. 10mm or 12mm dia.
4. Note down the position of upper disk, when jet is not running.
5. Note down the reading of height of water in the collecting tank.
6. As the jet strike the vane, position of upper disk is changed, note the reading in the scale to which vane is raised.
7. Put the weight of various values one by one to bring the vane to its initial position.
8. At this position finds out the discharge also.
9. The procedure is repeated for each value of flow rate by reducing the water supply.
10. This procedure can be repeated for different type of vanes and nozzle.

Observation table:-

Dia of nozzle =
Mass density of water ρ =
Area of collecting tank =
Area of nozzle =

Horizontal flat vane

When jet is not running, position of upper disk is at =

SNO	Discharge measurement				Balancing		Theoretical Force $F' = \rho Q^2/a$	Error in % $= F-F'/F'$
	Initial (cm)	Final (cm)	Time (sec)	Discharge (cm^3/sec) Q	Mass W (gm)	Force F (dyne)		

Inclined vane

When jet is not running, position of upper disk is at =

Angle of inclination $\beta = 45^0$

SNO	Discharge measurement				Balancing		Theoretical Force $F' = \rho Q^2(1-\cos\beta)/a$ (dyne)	Error in % $= F-F'/F'$
	Initial (cm)	Final (cm)	Time (sec)	Discharge (cm^3/sec) Q	Mass W (gm)	Force F (dyne)		

Curved hemispherical vane

When jet is not running, position of upper disk is at =

SNO	Discharge measurement				Balancing		Theoretical Force $F' = 2\rho Q^2/a$ (dyne)	Error in % = F-F'/F'
	Initial (cm)	Final (cm)	Time (sec)	Discharge (cm^3/sec) Q	Mass W (gm)	Force F (dyne)		

Precautions:-

1. Water flow should be steady and uniform.
2. The reading on the scale should be taken without any error.
3. The weight should be put slowly & one by one.
4. After changing the vane the flask should be closed tightly.

EXPERIMENT NO 2

Aim:- To determine the coefficient of discharge of Orifice meter.

Apparatus Used:- Orifice meter, installed on different pipes, arrangement of varying flow rate, U- tube manometer, collecting tube tank, vernier calliper tube etc.

Formula Used:-

$$C_d = = \frac{Q\sqrt{A^2 - a^2}}{A\, a \sqrt{2\, g\, \Delta h}}$$

Where

A = Cross section area of inlet
a = Cross section area of outlet
Δh = Head difference in manometer
Q = Discharge
C_d = Coefficient of discharge
g = Acceleration due to gravity

Theory:- Orifice meter are depending on Bernoulli's equation. Orificemeter is a device used for measuring the rate of fluid flowing through a pipe. It is a cheaper device then Venturimeter.

Procedure:-

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.
2. Now start the supply at water controlled by the stop valve.
3. One of the valves of any one of the pipe open and close all other of three.
4. Take the discharge reading for the particular flow.
5. Take the reading for the pressure head on from the u-tube manometer for correspondingreading of discharge.
6. Now take three readings for this pipe and calculate the C_d for that instrument usingformula.
7. Now close the valve and open valve of other diameter pipe and take the three readingfor this.
8. Similarly take the reading for all other diameter pipe and calculate C_d for each.

Observations:-

Diameter of Orifice meter =
Area of cross section =
Area of collecting tank =

Discharge					Manometer Reading				$Cd = \frac{Q\sqrt{A^2 - a^2}}{Aa\sqrt{2g\Delta h}}$
Initial reading	Final reading	Difference	Time (sec)	Q	h_1	h_2	h_2-h_1	h_2-h_1 $\Delta h = 13.6(h_2-h_1)$	

Result:-

Precautions:-

1. Keep the other valve closed while taking reading through one pipe.
2. The initial error in the manometer should be subtracted final reading.
3. The parallax error should be avoided.
4. Maintain a constant discharge for each reading.
5. The parallax error should be avoided while taking reading the manometer.

Viva Questions:-

1. Orificemeter are used for flow measuring. How?
2. Difference between Orificemeter and Venturimeter?

EXPERIMENT No 3

Aim:- To determine the coefficient of discharge of Notch (V , Rectangular and Trapezoidal types).

Apparatus Used:- Arrangement for finding the coefficient of discharge inclusive of supply tank, collecting tank, pointer, scale & different type of notches

Theory:- Notches are overflow structure where length of crest along the flow of water is accurately shaped to calculate discharge.

Formula Used:-

For V notch the discharge coefficient

$$C_d = \frac{Q}{\sqrt{2g}\, H^{5/2} \tan\theta / 2}\ 8/15$$

For Rectangular notch

$$C_d = \frac{Q}{2/3 \sqrt{2g}\, BH^{3/2}}$$

For Trapezoidal notch

$$C_d = \frac{Q}{(2/3) \sqrt{2g}\, (B + \tan\theta / 2)\, H^{3/2}}$$

Where:-

Q = Discharge

H =Height above crest level

θ = Angle of notch

B = Width of notch

Procedure:-

1. The notch under test is positioned at the end of tank with vertical sharp edge on theupstream side.
2. Open the inlet valve and fill water until the crest of notch.
3. Note down the height of crest level by pointer gauge.
4. Change the inlet supply and note the height of this level in the tank.
5. Note the volume of water collected in collecting tank for a particular time and findout the discharge.
6. Height and discharge readings for different flow rate are noted.

Observations:-

Breadths of tank

Length of tank =

Height of water to crest level for rectangular notch is =
Height of water to crest level for V notch =
Height of water to crest level for Trapezoidal notch =
Angle of V notch =
Width of Rectangular notch =

Type Of notch	Discharge					Final height reading above width	Head above crest level	C_d
	Initial height Of tank	Final height Of tank	Difference In height	Volume	Q			

Result:-

Precaution:-

1. Make the water level surface still, before takings the reading.
2. Reading noted should be free from parallax error.
3. The time of discharge is noted carefully.
4. Only the internal dimensions of collecting tank should be taken for consideration andcalculations.

Viva Questions:-

1. Differentiate between :-
   - Uniform and non-uniform flow
   - Steady and unsteady flow
2. Define notch?
3. What is coefficient of discharge?

EXPERIMENT No 4

Aim:- To determine the friction factor for the pipes.(Major Losses).

Apparatus Used:- A flow circuit of G. I. pipes of different diameter viz. 15 mm, 25 mm, 32 mm dia, U-tube differential manometer, collecting tank.

Theory:- Friction factor in pipes or Major losses:-

A pipe is a closed conduit through which fluid flows under the pressure. When in the pipe, fluid flows, some of potential energy is lost to overcome hydraulic resistance which is classified as:-

1. The viscous friction effect associated with fluid flow.
2. The local resistance which result from flow disturbances caused by

- ❖ Sudden expansion and contraction in pipe
- ❖ Obstruction in the form of valves, elbows and other pipe fittings.
- ❖ Curves and bend in the pipe.
- ❖ Entrance and exit losses.

The viscous friction loss or major loss in head potential energy due to friction is given by

$$h_f = \frac{4\,f\,l\,v^2}{2\,g\,d}$$

Hence the major head loss is friction loss

$$h_f = \frac{4\,f\,l\,v^2}{2\,g\,d}$$ -------------------Darey equation

Where,

h_f =Major head loss
l = Length of pipe
4f = Friction factor
V = Inlet velocity
g = Acceleration due to gravity
d = Diameter of pipe

Procedure:-

1. Note down the relevant dimensions as diameter and length of pipe betweenthe pressure tapping, area of collecting tank etc.
2. Pressure tapping of a pipe is kept open while for other pipe is closed.
3. The flow rate was adjusted to its maximum value. By maintaining suitable amount of steady flow in the pipe.
4. The discharge flowing in the circuit is recorded together with the water levelin the left and right limbs of manometer tube.
5. The flow rate is reduced in stages by means of flow control valve and thedischarge & reading of manometer are recorded.
6. This procedure is repeated by closing the pressure tapping of this pipe,together with other pipes and for opening of another pipe.

Observation:-

Diameter of pipe D =
Length of pipe between pressure tapping L =
Area of collecting tank =

SNo	Manometer Reading			Discharge Measurement				$F = \pi^2 gD^5/ 8LQ^2\ h_f$
	Left limb h_1 (cm)	Right limb H_2 (cm)	Difference of headin terms of water h_f $=13.6(h_1-h_2)$	Initial (cm)	Final (cm)	Time (sec)	Discharg eQ (cm3/sec)	
1.								
2.								
3.								
4.								

Result:-

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, notethe mean position carefully.
2. There in some water in collecting tank.
3. Carefully keep some level of fluid in inlet and outlet supply tank.

Viva Questions:-

1. Define major loss in pipe?
2. Define equilent pipe?
3. Define friction factor in the pipe?

EXPERIMENT NO 5

Aim:- To determine the coefficient of discharge of Venturimeter.

Apparatus Used:- Venturimeter, installed on different diameter pipes, arrangement of varying flow rate, U- tube manometer, collecting tube tank, vernier caliper tube etc.

Formula Used:-

$$C_d = \frac{Q\sqrt{A^2 - a^2}}{A\,a\sqrt{2\,g\,\Delta h}}$$

Where

A = Cross section area of inlet
a = Cross section area of outlet
Δh = Head difference in manometer
Q = Discharge
C_d = Coefficient of discharge
g = Acceleration due to gravity

Theory:-Venturimeter are depending on Bernoulli's equation. Venturimeter is a device used for measuring the rate of fluid flowing through a pipe. The consist of three part in short

1. Converging area part
2. Throat
3. Diverging part

Procedure:-

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.
2. Now start the supply at water controlled by the stop valve.
3. One of the valves of any one of the pipe open and close all other of three.
4. Take the discharge reading for the particular flow.
5. Take the reading for the pressure head on from the u-tube manometer for correspondingreading of discharge.
6. Now take three readings for this pipe and calculate the C_d for that instrument usingformula.
7. Now close the valve and open valve of other diameter pipe and take the three readingfor this.
8. Similarly take the reading for all other diameter pipe and calculate C_d for each.

Observations:-

Diameter of Venturimeter=

Area of cross section =

Venturimeter=

Area of collecting tank=

Discharge					Manometer Reading				$Cd = \frac{Q\sqrt{A^2 - a^2}}{Aa\sqrt{2g\Delta h}}$
Initial reading	Final reading	Difference	Time (sec)	Q	h_1	h_2	$h_2 - h_1$	$h_2 - h_1$ $\Delta h = 13.6(h_2 - h_1)$	

Result:-

Precautions:-

1. Keep the other valve closed while taking reading through one pipe.
2. The initial error in the manometer should be subtracted final reading.
3. The parallax error should be avoided.
4. Maintain a constant discharge for each reading.
5. The parallax error should be avoided while taking reading the manometer.

Viva Questions:-

1. Venturimeter are used for flow measuring. How?
2. Define co efficient of discharge?
3. Define parallax error?
4. Define converging area part?
5. Define throat?
6. Define diverging part?

EXPERIMENT No 6

Aim:- To determine the coefficient of discharge, contraction & velocity of an Orifice.

Apparatus Used:- Supply tank with overflow arrangement, Orifice plate of different diameter, hook gauge, collecting tank, piezometric tube.

Formula Used:-

$$C_d = \frac{Q_{actual}}{Q_{theoretical}}$$

$Q_{theatrical}$ =Theoretical velocity x Theoretical area

$$= \sqrt{2gh} \cdot a$$

$$C_d = \frac{Q}{a\sqrt{2gh}}$$

C_v = Actual velocity of jet at vena contracted / Theoretical velocity

$$C_v = V / V_{TH} = \sqrt{2x^2 / 2y} \cdot \sqrt{1} / \sqrt{2gh} = x / 2\sqrt{yh}$$

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Coefficient of contraction = Area of jet at vena contractual / Theoretical velocity

$$Cc = \frac{a_c}{a}$$

Theory:- A mouthpiece is a short length of pipe which is two or three times its diameter in length. If there pipe is filled externally to the orifices, the mouthpiece is called external cylindrical mouthpiece and discharge through orifice increase is a small opening of any cross-section on the side of bottom of the tank, through which the fluid is flowing orifice coefficient of velocity is defined as the ratio of two actual discharge to orifice ratio of the actual velocity of the jet at vena- contractual to the coefficient of theoretical velocity of the jet coefficient of contraction of defined as ratio of the actual velocity of jet at vena- contractor.

Vena- Contracta:- The fluid out is in form of jet goes on contracting form orifice up to dispute of about ½ the orifice dia. After the expend this least relation.

Coefficient of velocity:- It is a ratio of actual velocity jet at vena-contracta to theoretical velocity.

Coefficient of contraction:- $C_d = \frac{a_c}{a}$

$$= \frac{\text{Area of jet}}{\text{Area of orifice}}$$

Coefficient of discharge:- $C_d = \frac{Q_{actual}}{Q_{theoretical}}$

Procedure:-

1. Set the mouthpiece of orifice of which the C_c, C_u, C_d are to be determined.
2. Note the initial height of water in the steady flow tank and the height of datum from the bottom of orifice and mouthpiece. These remains constant for a particular mouthpiece or orifice.
3. By using the stop valve, set a particular flow in tank and tank height of water in tank.
4. Take the reading of discharge on this particular flow.
5. Using hook gauge, find the volume of Xo Y for mouthpiece.
6. Take three readings using hook gauge for one particular orifice.
7. Using the formula get value of C_d, C_u, and C_c for a particular orifice and mouthpiece.

Observation:-

x' + y' are reading on horizontal/vertical scale

a_o	$h=\mu\ a_o$	x'	y'	$X= x'-x_0y$	$Y= y'-y_0$	Cu=x/2gh	Average

h = Reading on piezometer
a0 = Reading on piezometer at level on centre of mouthpiece
y0 = Reading on vertical scale at exit of orifice
x0 = Reading on horizontal scale at exit of orifice

Sr.No	X	Z P	F R	volume	Time	Q = V	C_d=Q/2gh	Average
1.								
2.								
3.								
4.								

Result:-

Precautions:-

1. Take the reading of discharge accurately.

2. Take value of h without any parallax error.
3. Set the orifice and mouthpiece.
4. Height of water in the steady flow.
5. Take reading from hook gauge carefully.

Viva Questions:-

1. Define Orifice?
2. Define Mouth piece?
3. Define vena contracta?
4. Define co efficient of velocity?

EXPERIMENT No 7

Aim:- To verify the Bernoulli's theorem.

Apparatus Used:- A supply tank of water, a tapered inclined pipe fitted with no. of piezometer tubes point, measuring tank, scale, stop watch.

Theory:- Bernoulli's theorem states that when there is a continues connection between the particle of flowing mass liquid, the total energy of any sector of flow will remain same provided there is no reduction or addition at any point.

Formula Used:-

$$H_1 = Z_1 + p_1/w + V_1^2/2g$$

$$H_2 = Z_2 + p_2/w + V_2^2/2g$$

Procedure:-

1. Open the inlet valve slowly and allow the water to flow from the supply tank.
2. Now adjust the flow to get a constant head in the supply tank to make flow in and outflow equal.
3. Under this condition the pressure head will become constant in the piezometer tubes.
4. Note down the quantity of water collected in the measuring tank for a given interval oftime.
5. Compute the area of cross-section under the piezometer tube.
6. Compute the area of cross- section under the tube.
7. Change the inlet and outlet supply and note the reading.
8. Take at least three readings as described in the above steps.

	1	2	3	4	5	6	7	8	9	10	11
Discharge Of piezometer Tube from inlet											
Area of Cross-section Under foot Of each point											
Velocity Of water Under foot Of each point											
$V^2/2g$											
p/ρ											
p/ρ+ $V^2/2g$											

Result:-

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometertubes, note the mean position carefully.
2. Carefully keep some level of fluid in inlet and outlet supply tank.

Viva Questions:-

1. Briefly explain the various terms involved in Bernoulli’s equation?
2. Assumption made to get Bernoulli’s equation from Euler’s equation by made?
3. What is piezometer tube?

EXPERIMENT No 8

Aim:- To find critical Reynolds number for a pipe flow.
Apparatus Used:- Flow condition inlet supply, elliptical belt type arrangement for coloured fluid with regulating valve, collecting tank.

Formula Used:- Reynolds No = $\frac{\text{Inertia force}}{\text{Viscous force}}$

Theory:-

Reynolds Number:-

It is defined as ratio of inertia force of a flowing fluid and the viscous force of the fluid. The expression for Reynolds number is obtained as:-

Inertia force(Fi) = mass . acceleration of flowing

$= \delta . \text{ Volume. Velocity/ time}$

$= \delta . \frac{\text{Volume.}}{\text{time}}\text{Velocity}$

$= \delta \text{ .area .Volume . Velocity}$

$= \delta \text{ .A .V}^2$

Viscous force(Fv) = Shear stress . area

$= \tau . A$

$= \mu \text{ du/dy . A}$

$= \mu VA/\tau$

By definition Reynolds number:-

$Re = Fi/Fu = \delta AV2/\mu/t.A$

$= V.L/\mu/s$

$= V.L/v$

{ $v = \mu / \rho$ is kinematics viscosity of the fluid }

In case of pipe flow, the linear dimension L is taken as dia (d) hence Reynolds number for pipe flow is :-

$Re = V.d/v$ or

$Re = \rho Vd/v$

Procedure:-

1. Fill the supply tank some times before the experiment.
2. The calculated fluid is filled as container.
3. Now set the discharge by using the valve of that particular flow can be obtained.
4. The type of flow of rate is glass tube is made to be known by opening the valve of dyecontainer.
5. Take the reading of discharge for particular flow.
6. Using the formula set the Reynolds no. for that particular flow, aspect the above procedurefor all remaining flow.

Observation:-

Type	Time	Discharge				$Q=m^3/3$	$Re=4Q/\pi\Delta V$
		Initial	Final	Difference	Volume		

Result:-

Precaution:-

1. Take reading of discharge accurately.
2. Set the discharge value accurately for each flow.

Viva Questions:-

1. Reynolds number importance?
2. Describe the Reynolds number experiments to demonstrate the two type of flow?
3. Define laminar flow, transition flow and turbulent flow?

EXPERIMENT No 9

Aim: - To determine the Meta-centric height of a floating body.

Apparatus Used: - Take tank 2/3 full of water, floating vessel or pontoon fitted with a pointed pointer moving on a graduated scale, with weights adjusted on a horizontal beam.

Theory: - Consider a floating body which is partially immersed in the liquid, when such a body is tilted, the center of buoyancy shifts from its original position 'B' to 'B' (The point of application of buoyant force or upward force is known as center of G which may be below or above the center of buoyancy remain same and couple acts on the body. Due to this couple the body remains stable.

At rest both the points G and B also Fb x Wc act through the same vertical line but in opposite direction. For small change (θ) B shifted to B.

The point of intersection M of original vertical line through B and G with the new vertical, line passing through 'B' is known as metacenter. The distance between G and M is known as metacenter height which is measure of static stability.

Formula Used: - $$GM = \frac{W_m . X_d}{(W_c + W_m)\tan\theta}$$

Where: -

W_m is unbalanced mass or weight.

Wc is weight of pontoon or anybody.

X_d is the distance from the center of pointer to striper or unbalanced weight.

θ is angle of tilt or heel.

Procedure: -

1. Note down the dimensions of the collecting tank, mass density of water.
2. Note down the water level when pontoon is outside the tank.
3. Note down the water level when pontoon is inside the tank and their difference.
4. Fix the strips at equal distance from the center.
5. Put the weight on one of the hanger which gives the unbalanced mass.
6. Take the reading of the distance from center and angle made by pointer on arc.
7. The procedure can be repeated for other positioned and values of unbalancedmass.

Observation Table:-

Length of the tank =
Width of the tank =
Area of the tank =
Initial level of the water without pontoon =
Final level of the water without pontoon =
Difference in height of water(X) = $X_2 - X_1$ =

Height of waterIn tank with Pontoon (X_2) (m)	Difference inHeight $X = X_2 - X_1$ (m)	Weight of Pontoon $W_c = XA\rho$ (kg)	Unbalance dMass, Wm (kg)	Q	G M = Metacentri cHeight (m)	X_d (m)

Result: - Meta centric height of the pontoon is measured with different positions and weights.

Precautions: -

1. The reading taking carefully without parallax error.
2. Put the weight on the hanger one by one.
3. Wait for pontoon to be stable before taking readings.
4. Strips should be placed at equal distance from the centre.

Viva Questions:-

1. Define Buoyancy?
2. Define Meta-centre?
3. Define Meta- centric height?
4. With respect to the position of metacentre, state the condition of equilibrium for afloating body?

EXPERIMENT No 10

Aim:- To determine the minor losses due to sudden enlargement, sudden contraction and bend.

Apparatus Used:- A flow circuit of G. I. pipes of different pipe fittings viz. Large bend, Small bend, Elbow, Sudden enlargement from 25 mm dia to 50 mm dia, Sudden contraction from 50 mm dia to 25 mm dia, U-tube differential manometer, collecting tank.

Theory:- Minor Losses:-

The local or 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 velocitydistribution and may result in eddy formation.

Sudden Enlargement:-

Two pipe of cross-sectional area A1 and A2 flanged together with a constant velocity fluid flowing from smaller diameter pipe. This flow breaks away from edges of narrow edges section, eddies from and resulting turbulence cause dissipation of energy. The initiations and onset of disturbances in turbulence is due to fluid momentum and its area. It is given by:-

$$h_{exit} = V2/2g$$

Eddy loss:-

Because the expansion loss is expended exclusively on eddy formation and continues substanceof rotational motion of fluid masses.

Sudden Contraction:-

It represents a pipe line in which abrupt contraction occurs.
Inspection of the flowpattern reveals that it exists in two phases.

$$h_{con} = (V_c - V_2)2/2g$$

Where

V_c = velocity at vena contracta

Losses at bends, elbows and other fittings:-

The flow pattern regarding separation and eddying in region of separations in bends, valves. The resulting head loss due to energy dissipation can be prescribed by the relation h = KV2/2g.Where V is the average flow velocity and the resistance coefficient K depends on parameter defining the geometry of the section and flow.

Resistances of large sizes elbows can be reduced appreciably by splitting the flow into a number of streams by a jet of guide vanes called cascades.

Procedure:-

1. Note down the relevant dimensions as diameter and length of pipe between the pressuretapping, area of collecting tank etc.
2. Pressure tapping of a pipe a is kept open while for other pipe is closed.
3. The flow rate was adjusted to its maximum value. By maintaining suitable amount ofsteady flow in the pipe.
4. The discharge flowing in the circuit is recorded together with the water level in the leftand right limbs of manometer tube.
5. The flow rate is reduced in stages by means of flow control valve and the discharge &reading of manometer are recorded.
6. This procedure is repeated by closing the pressure tapping of this pipe, together withother pipes and for opening of another pipe.

Observation:-

Diameter of pipe D =Length of pipe between pressure tapping L =

Area of collecting tank =Types of the fitting =

SNo	Manometer Reading			Discharge Measurement				Loss of coefficientK $=2g/V^2\ h_L$
	Left limb h_1 (cm)	Right limb h_2 (cm)	Difference of head in terms of water $h_f = 13.6(h_1 - h_2)$	Initial (cm)	Final (cm)	Time (sec)	Discharg eQ (cm^3/sec)	
1.								
2.								
3.								
4.								

Result:-

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes,note the mean position carefully.
2. There in some water in collecting tank.
3. Carefully keep some level of fluid in inlet and outlet supply tank.

Viva Questions:-

1. Define hydraulic gradient and total energy lines?

2. Define eddy loss?
3. Define sudden contraction?