FLUID MECHANICS LAB

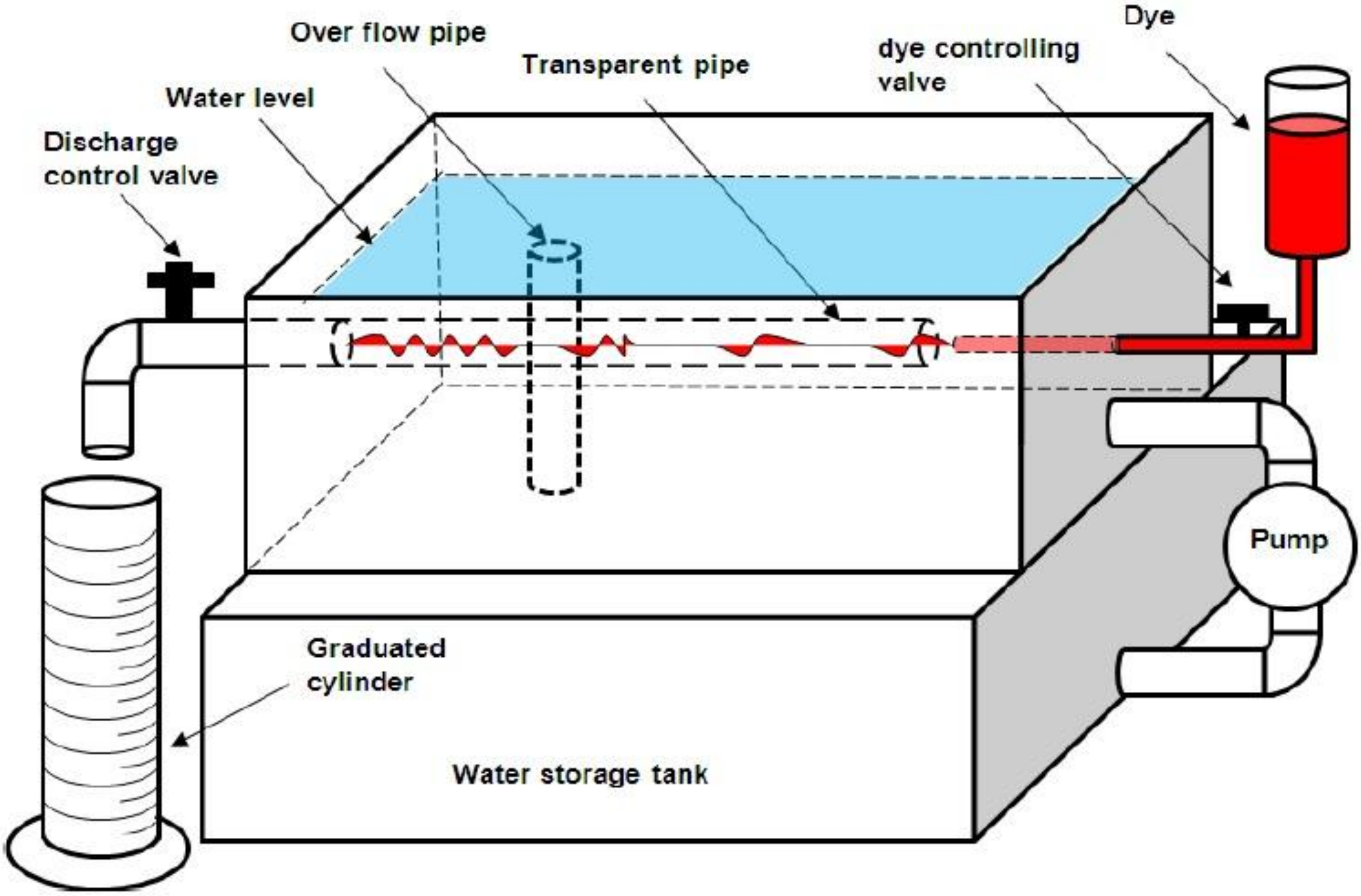
SECOND YEAR

Experiment No.: 1

Name of Experiment: Reynolds Number (Re)

Objective: To verify (Re) number and to determine the types of flow.

Apparatus: Experiment instrument, Cylinder and Stop watch.



Calculation:

$\mathbf{A} = \frac{\pi}{4}\mathbf{d}^2$ Where $\mathbf{d = 3.4\ cm}$

$\mathbf{Q} = \frac{\mathbf{Vol.}}{\mathbf{time}}$ $\mathbf{V} = \frac{\mathbf{Q}}{\mathbf{A}}$

$\mathbf{Re} = \frac{\mathbf{V.d}}{\boldsymbol{\nu}}$ Where $\boldsymbol{\nu}$ is the **kinematic viscosity**

If **Re** < 2000 the flow is **Laminar**

2000 < **Re** < 4000 the flow is **Transition**

Re > 4000 the flow is **Turbulent**

Kinematic viscosity of water

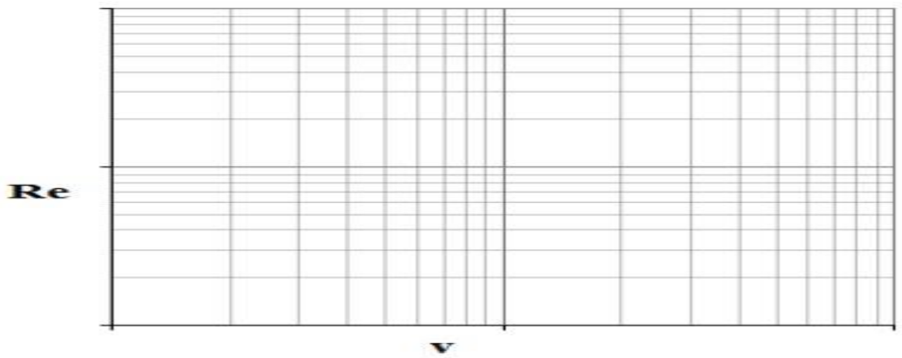
Temp. C°	ν cm^2/sec	Temp. C°	ν cm^2/sec	Temp. C°	ν cm^2/sec	Temp. C°	ν cm^2/sec
10	0.01308	14	0.01172	18	0.01057	22	0.00960
11	0.01271	15	0.01141	19	0.01032	23	0.00936
12	0.01237	16	0.01112	20	0.01007	24	0.00917
13	0.01204	17	0.01048	21	0.00983	25	0.00899

Procedure:

1. Switch on the pump to make flow of water to the experiment tank.
2. Open the discharge valve to allow the water flow through the test pipe.
3. Control the discharge, and open the dye valve letting the dye flow in the experiment pipe and look the dye behavior, if the dye is preserved as a filament at certain layer then the flow is laminar, if the dye diffuses in the water after a short distance then the flow is transient, while a sudden scatter of the dye represent turbulent flow.
4. Measure the discharge by the stop watch and scale cylinder.
5. Measure temperature of the water by the thermometer.
6. Repeat the procedure from 3 to 5 times to get different Re numbers.

Discussions:

1. Plot (**Re**) versus velocity (**v**) on log-log paper.
2. Why the water height is held constant in the tank



FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 1

Name of Experiment: Reynolds Number (Re)

Date of Experiment:

Name of the student:

Class: **Group:**

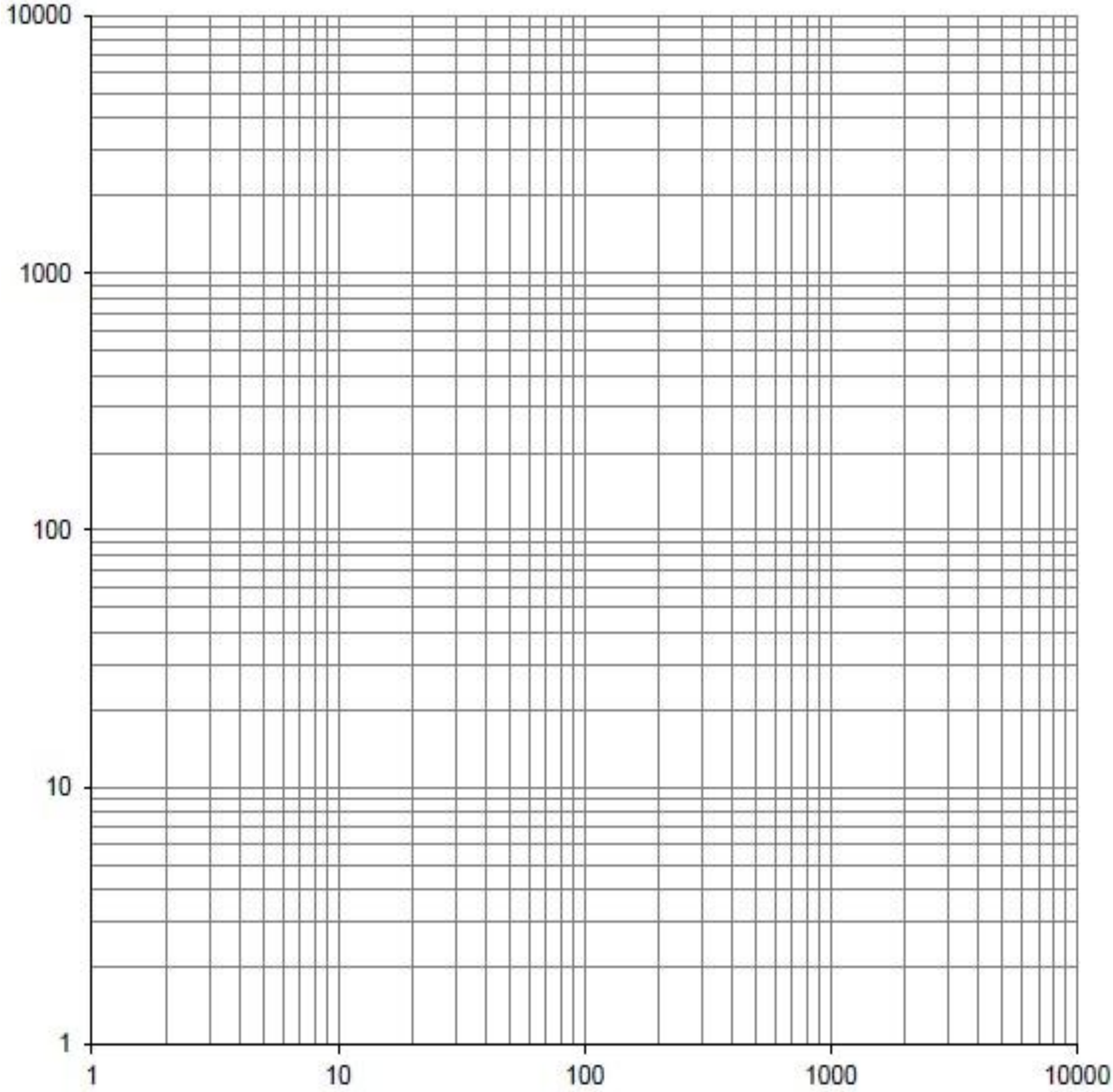
Temperature:

Kinematic viscosity:

No.	Vol. cm^3	time sec	Q cm^3/sec	v cm/sec	Re	Flow Type	
						Theoretical	Visual
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Signature

Prepared by: Yaseen W. Aziz



FLUID MECHANICS LAB

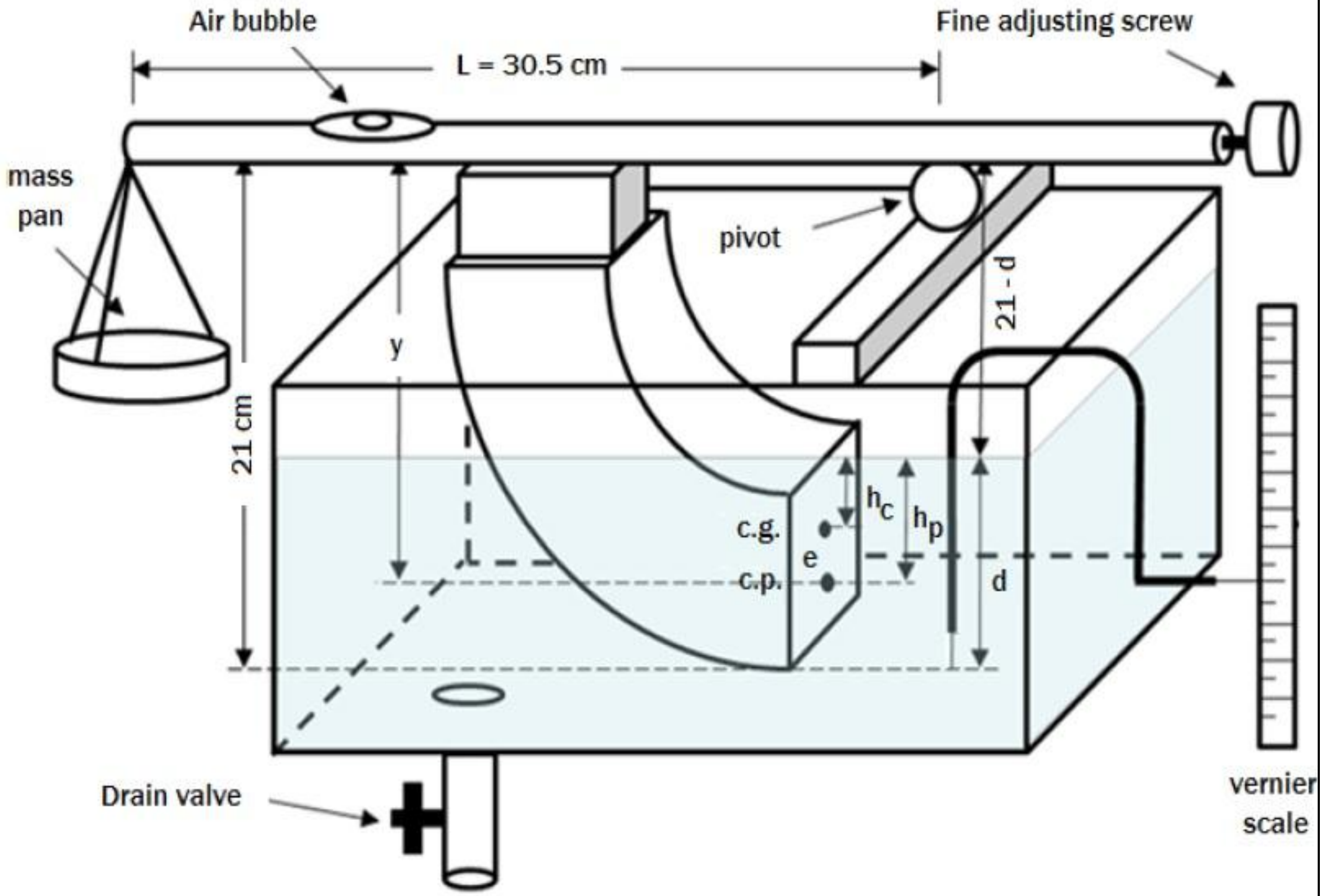
SECOND YEAR

Experiment No.: 2

Name of Experiment: Center of pressure on the plane (Partially and Submerged)

Objective: To determine position of the center of pressure on the rectangular face of the submerged body.

Apparatus: 1- Experiment instrument, 2- container, 3- pointer and 4- weights



Procedure:

1. Check the air bubble to make sure that the balance arm is horizontal, if not, turn the adjusting screw to bring the bubble to the centre.
2. Close the drainage valve, slowly add water to the tank till it reaches the lower edge of the submerged body.
3. Make zero reading of the scale with the surface of the water.

4. First trial place (30 gm) mass on the pan.
5. Add water to the tank to bring the bubble to the center, and record the water level (d).
6. Repeat steps (4) & (5) for several times increasing the mass in each run.

Calculation

$$y = \frac{M.g.L}{\gamma.hc.A}$$

$$hp = y - (21 - d)$$

$$e_{act} = hp - hc \qquad\qquad e_{theo} = \frac{Ic}{hc.A}$$

a. For partially submerged:

$$A = 7.5\,(d) \qquad hc = \frac{d}{2} \qquad Ic = \frac{7.5\,(d)^3}{12}$$

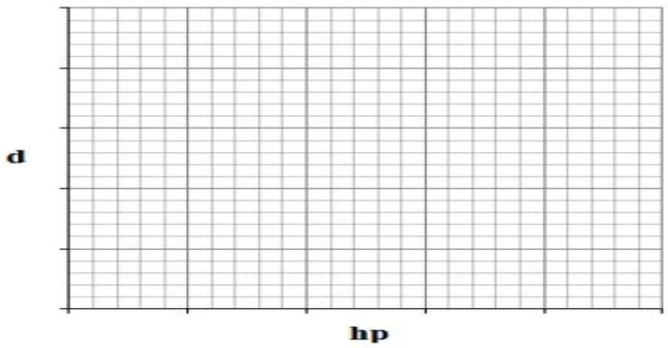
b. For completely submerged:

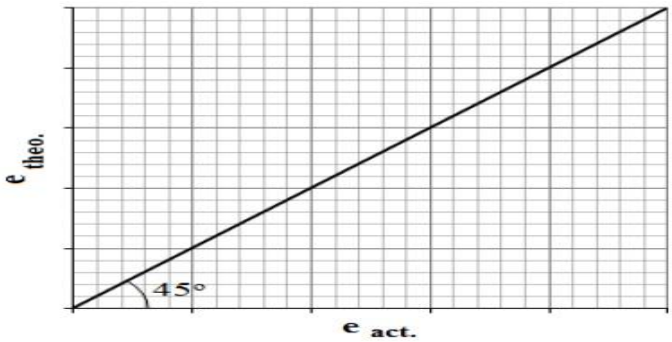
$$A = 7.5\,(10) \qquad hc = d - 5 \qquad Ic = \frac{7.5\,(10)^3}{12}$$

Plot **d** versus **h**$_p$ and **e**$_{theo}$ versus **e**$_{act}$ and discuss the graphs.

Discussion:

1. Discuss the graphs (**d** versus **hp**) and (**e**$_{th}$ versus **e**$_{act}$).
2. Where do you expect the position of c.p. with respect to c.g. for an inclined or vertically immersed surface? Why?
3. What would happen to c.p. if the water is replaced by a more dense liquid?
4. Sometimes c.p. concides with c.g. , when this condition occur? Why?





FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 2

Name of Experiment: Center of pressure on plane submerged body

Date of Experiment:

Name of the student:

Class: **Group:**

No.	Mass gm	d cm	hc cm	Area cm^2	y cm	hp cm	e_{act} cm	e_{theo} cm
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Signature

FLUID MECHANICS LAB

SECOND YEAR

Experiment No.: 3

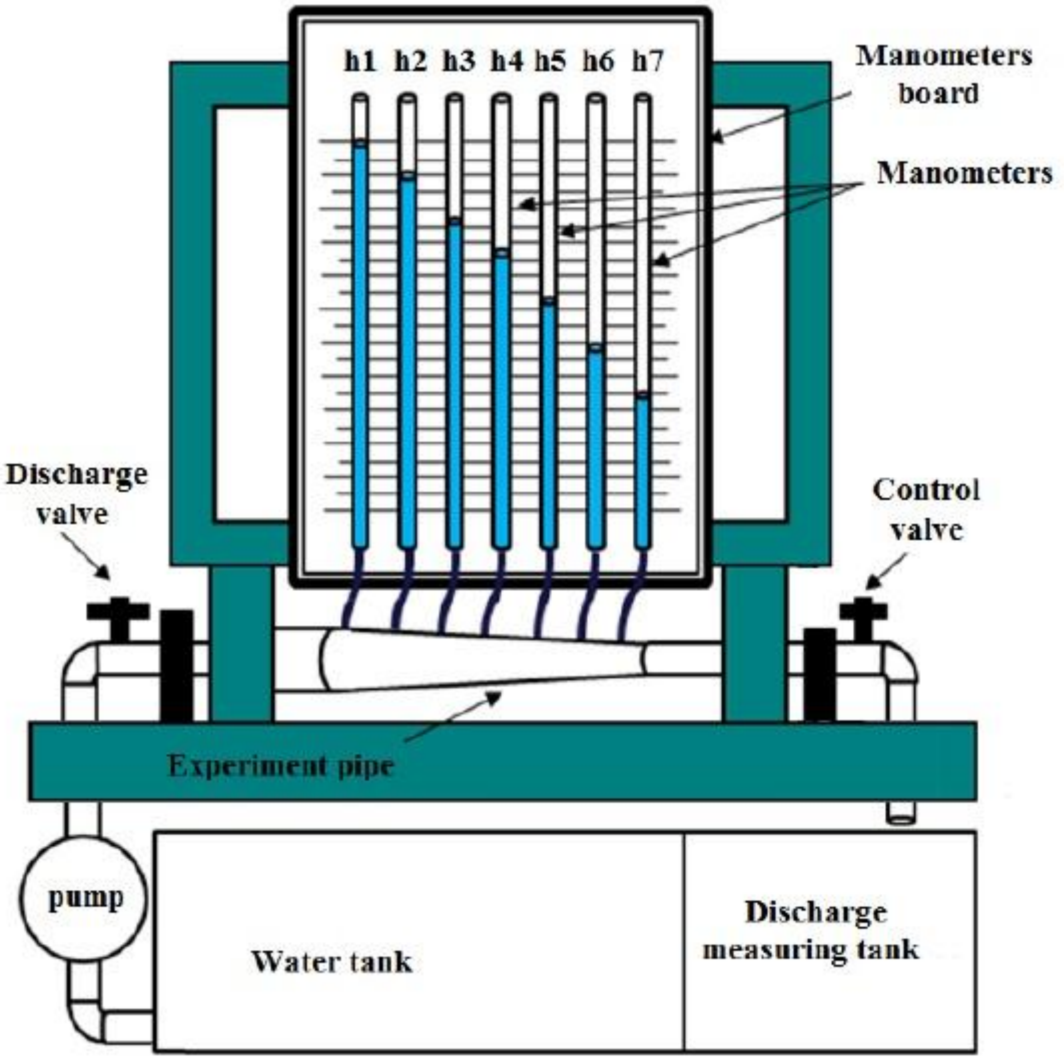
Name of Experiment: Total head equation

Introduction

Bernoulli stated that the sum of pressure head, velocity head and elevation head for ideal Incompressible fluid is constant at all points in the flow system. This condition is valid for steady one dimensional flow and ideal fluid (frictionless and incompressible), so the only forces present are the pressure forces and gravity forces.

Objective: To demonstrate Bernoulli equation.

Apparatus: Experiment instrument, stop watch and discharge measuring tank.



Procedure:

1. Switch on the pump, Open discharge valve to pass flow through th pipe and close the control valve until the water rises completely in each manometer.

2. Slowly open the control valve and open the discharge valve on a define flow.

3. Wait until the water level become stable in the piezometric tubes.

4. measure the water level in each piezometer on the scale board (h).

5. Measure the discharge passing through the pipe by the control tank and the stop watch (for accuracy take two or more trials and take the average between them).

6. Repeat the procedure several times by increasing the discharge in each run.

Calculations:

d_1=2.54 cm **d_3=1.95 cm** **d_5=1.7 cm** **d_7=1.58 cm**

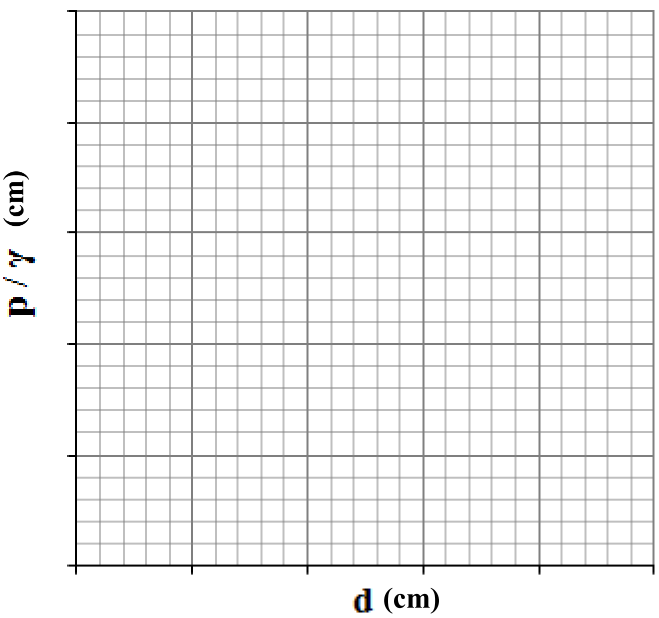
d_2=2.2 cm **d_4=1.85 cm** **d_6=1.64 cm**

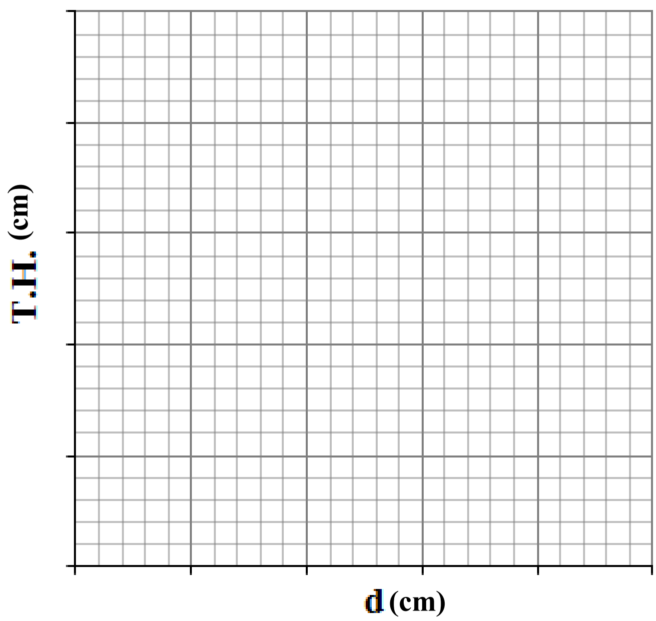
$A = \frac{\pi}{4} d^2$; $Q = \frac{Vol.}{Time}$; $v = \frac{Q}{A}$

$\text{Total head} = z + \frac{P}{\gamma} + \frac{v^2}{2g}$ Since the experiment pipe is horizontal the elevation head can be removed

From the equation.

Draw the relationship between (P/γ with d) and (Total head (T.H). with distance))





Discussions:

1. Discuss the results and graphs
2. Why the water levels in the various piezometric tubes are different?
3. What will be happen if the experiment tube placed vertically?
4. What do you expect for total head in the reservoir with depth (y) and considering the datum at the bottom of the reservoir? Explain.

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 3

Name of Experiment: Total head equation

Date of Experiment:

Name of the student:

Class: **Group:**

No.	Vol. cm^3	time sec	Q cm^3/sec	Sections	1	2	3	4	5	6	7
1				P/γ cm							
				v cm/sec							
				$v^2/2g$ cm							
				Total head cm							
2				P/γ cm							
				v cm/sec							
				v2/2g cm							
				Total head cm							
3				P/γ cm							
				v cm/sec							
				v2/2g cm							
				Total head cm							
4				P/γ cm							
				v cm/sec							
				v2/2g cm							
				Total head cm							

Signature

FLUID MECHANICS LAB

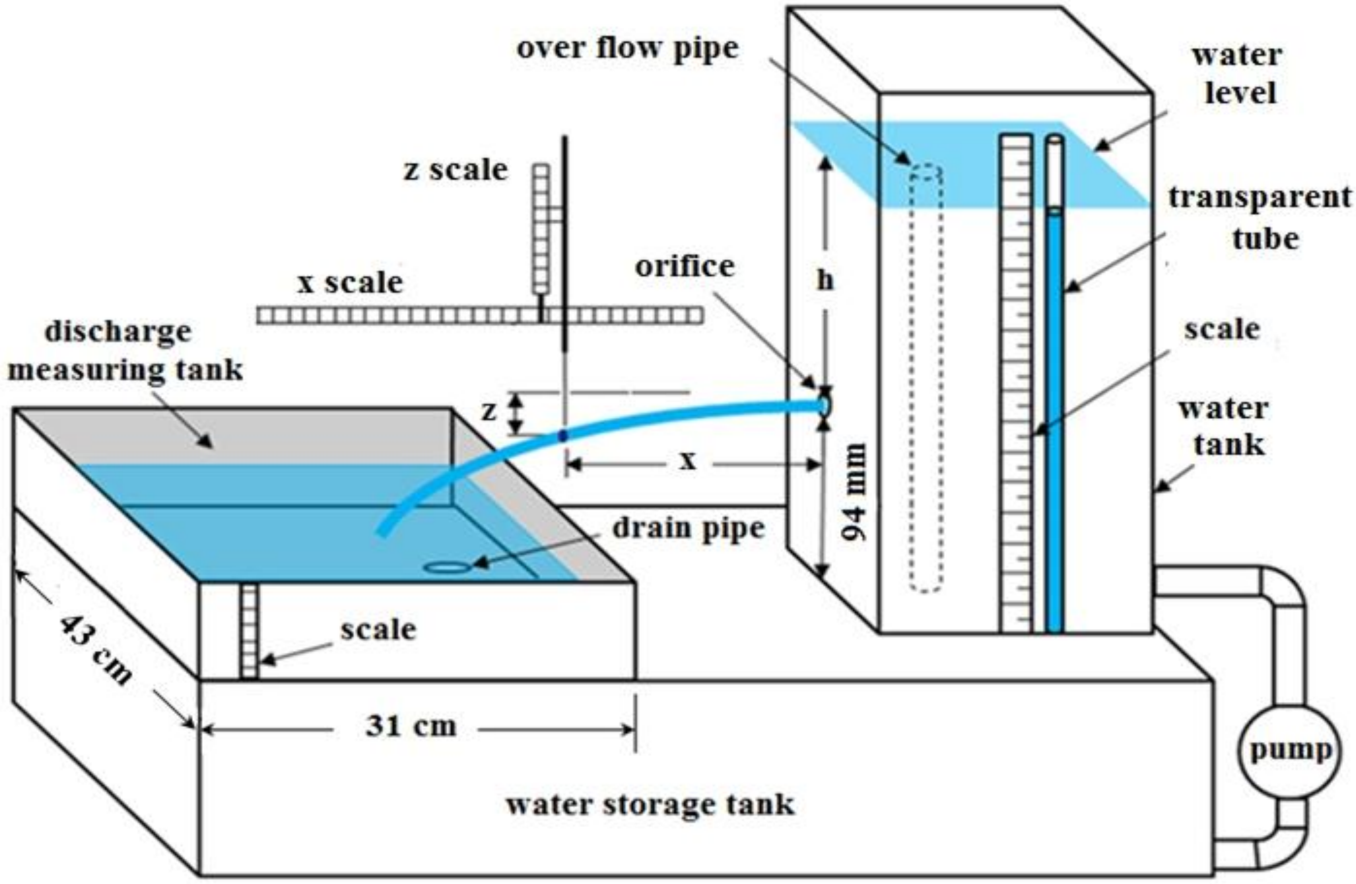
SECOND YEAR

Experiment No.: 4

Name of Experiment: Flow through orifice

Introduction:
An orifice is an opening in the wall of a tank or in a plate which may be fitted in a pipe such that the plate is normal to the pipe axis. An orifice is used for the discharge measurement. Usually an orifice has a sharp edge.

Objective: To find the contraction coefficient and contraction diameter for flow through an orifice. In addition, to find the discharge and velocity coefficient .
Apparatus: Experiment instrument and Stop watch.



Procedure:

1. Switch on the pump, allow the water to rise in the tank till it reach the overflow pipe and It flows through this pipe.

2. Measure head of the water above the orifice (h).

3. Measure the X and Z distance by pointer.

4. Measure the discharge by cylinder and the stop watch.
5. Repeat steps (2 – 4) several times for different heads.

Calculation:

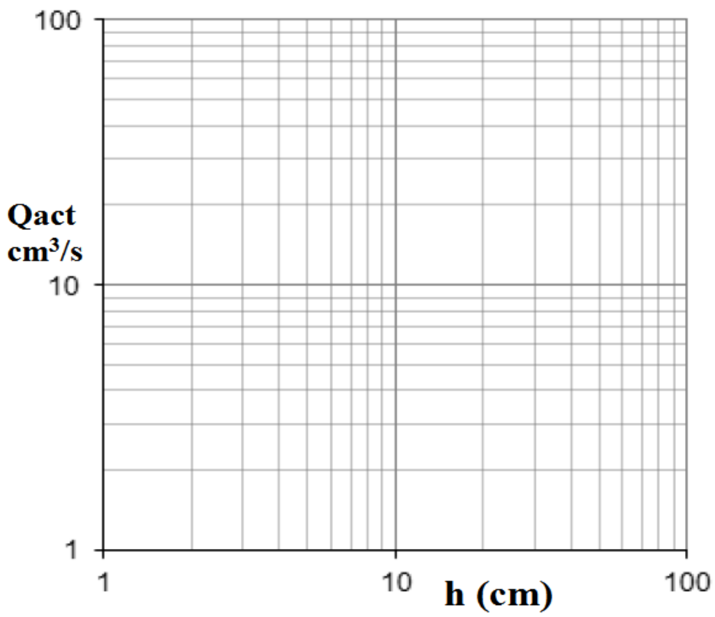
$$Q_{act.} = \frac{\text{Volume}}{\text{Time}} \qquad\qquad C_v = \frac{X}{\sqrt{4\,Z\,h}}$$

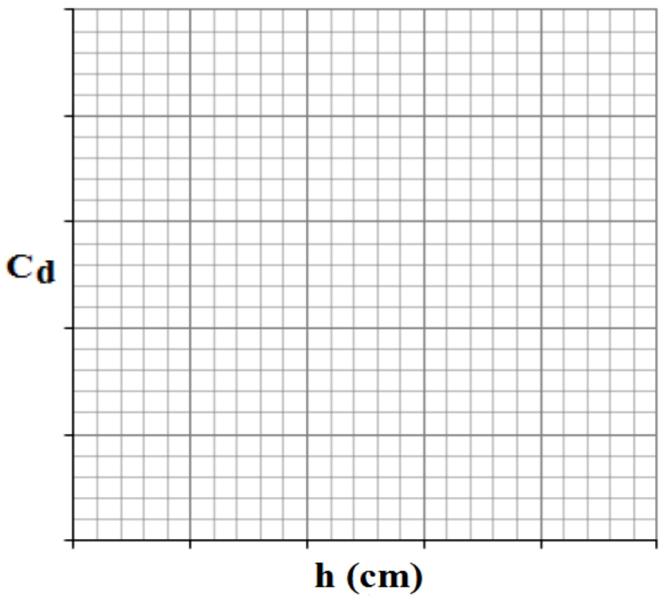
$A_o = \frac{\pi}{4} d_o^2$, where d_o is the orifice diameter equal to (0.96 cm)

$$Q_{th.} = A_o \sqrt{2gh}$$

$$C_d = \frac{Q_{act.}}{Q_{th.}} \qquad\qquad C_c = \frac{C_d}{C_v}$$

$$A_c = C_c * A_o \qquad\qquad d_c = \sqrt{\frac{4}{\pi} A_c}$$





Discussions:

1. Discuss graph (Q_{act}) versus (h) on log-log paper.
2. Discuss (Cd) versus (h).
3. What are the applications of the experiment?

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 4

Name of Experiment: Flow through orifice

Date of Experiment:

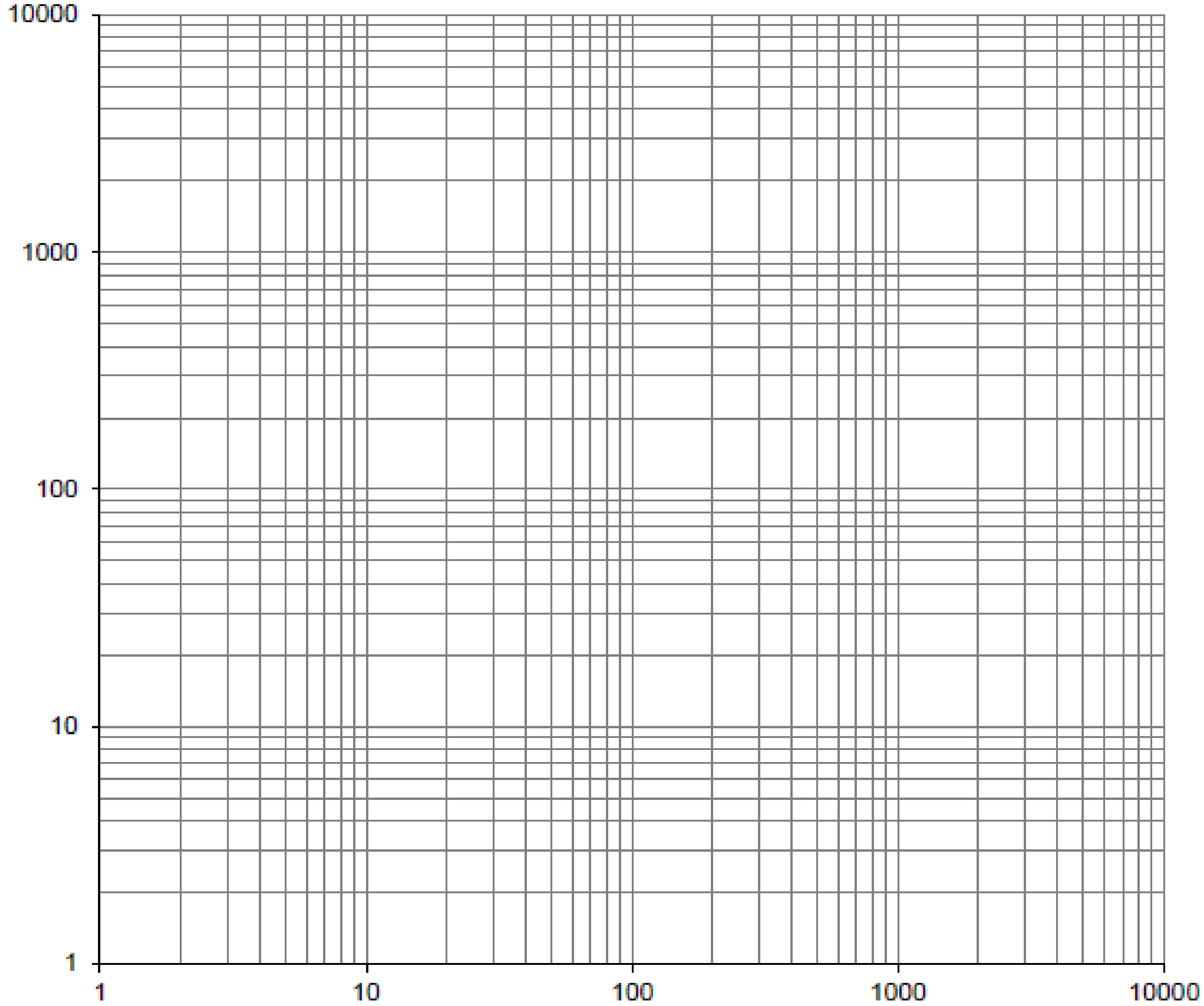
Name of the student:

Class: **Group:**

No.	h cm	X cm	Z cm	Vol. cm^3	time sec.	Qact. cm^3/sec.	Qth. cm^3/sec.	C_v	C_d	C_c	d_c cm
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

Signature

Prepared by: Yaseen W. Aziz



FLUID MECHANICS LAB

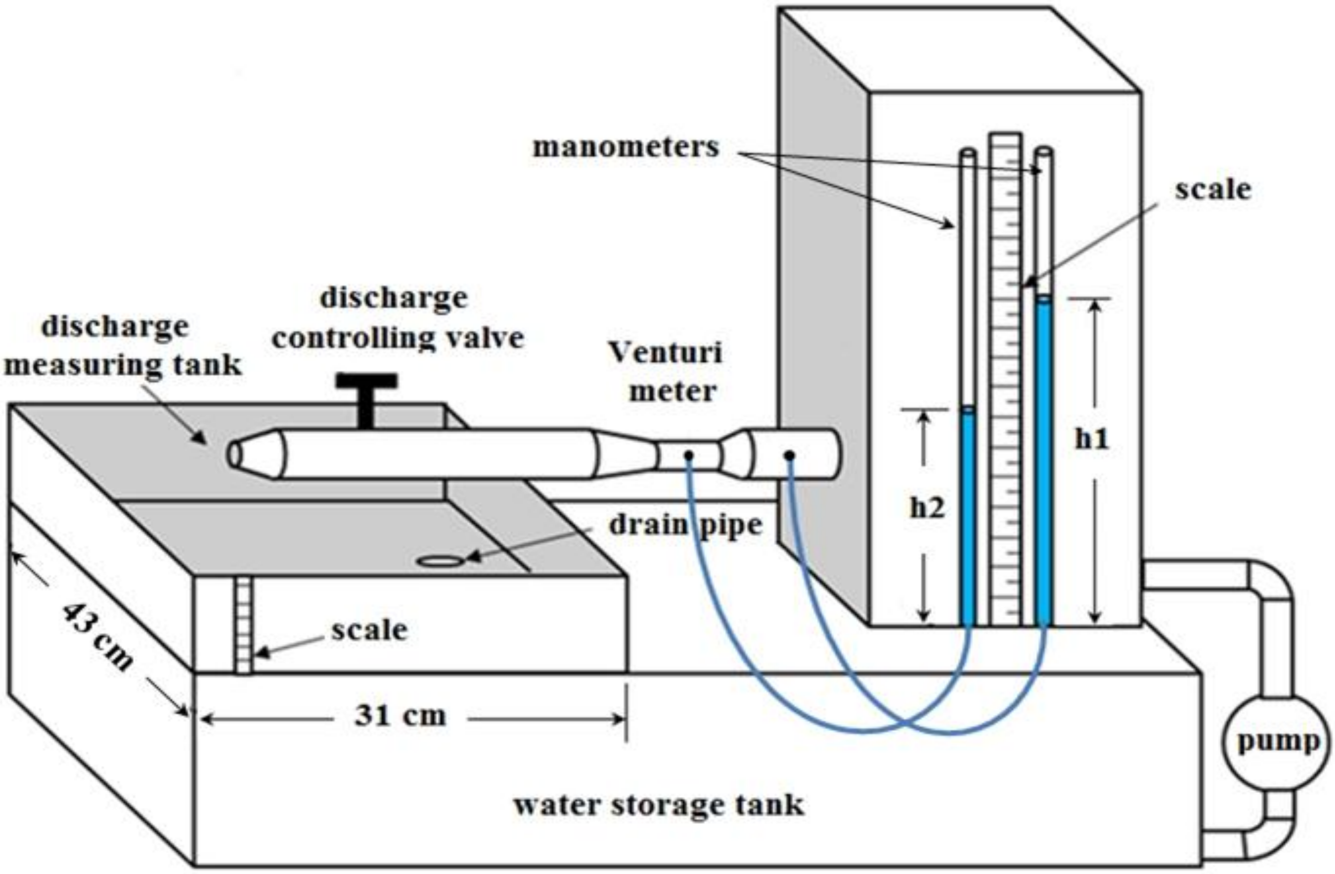
SECOND YEAR

Experiment No.: 5

Name of Experiment: Venturi meter

Objective: To find the discharge coefficient (C_d) for a given venturi meter.

Apparatus: venturi meter, water collecting tank, manometer, and Stop watch.



Procedure:

1. At the beginning fill the storage tank by water, then switch on the pump to fill the the overhead tank wait until the water flows through the over flow pipe.
2. Measure the pressure head of the water at sections (1) and (2) by the manometers which they are h_1 and h_2.
3. Measure the discharge using cylinder and the stop watch.
4. Repeat the same procedure several times for different discharges.

5. Measure temperature of the water using the thermometer.

Calculation:

d_1 = 3.18 cm, **d_2 = 1.55 cm**

$$C_d = \frac{Q_{act.}}{Q_{th.}}$$

$$Q_{act.} = \frac{Vol.}{Time}$$

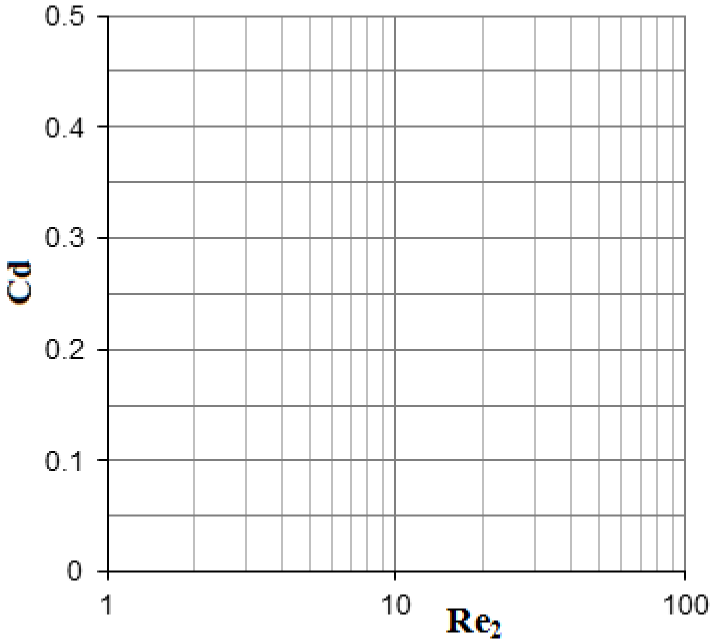
$$V_2 = \sqrt{\frac{2g\,\Delta h}{1-(A_2/A_1)^2}}$$ Where: $\Delta h = h_1 - h_2$

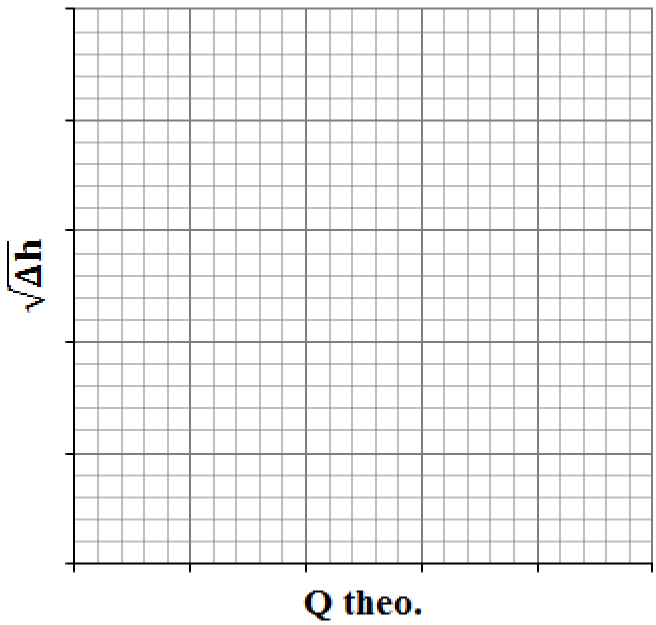
$$Q_{th.} = V_2 \,.\, A_2$$

$$Re_2 = \frac{V_2 . d_2}{\nu}$$

Plot the following graphs

1. C_d versus Re_2 on semi-log paper. 2. $(\Delta h)^{0.5}$ versus $Q_{theo.}$ on ordinary paper.





Discussions:

1. Discuss the graph C_d versus Re_2.
2. Discuss the graph $\sqrt{\Delta h}$ versus $Q_{th.}$, then explain what does the slope of the line mean.

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 5

Name of Experiment: Venturi meter

Date of Experiment:

Name of the student:

Class: **Group:**

Temperature:

Kinematic viscosity:

No.	Vol. cm^3	time sec	$Q_{act.}$ cm^3/sec	h1 cm	h2 cm	Δh cm	$Q_{th.}$ cm^3/sec	Cd	Re_2
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Signature

FLUID MECHANICS LAB

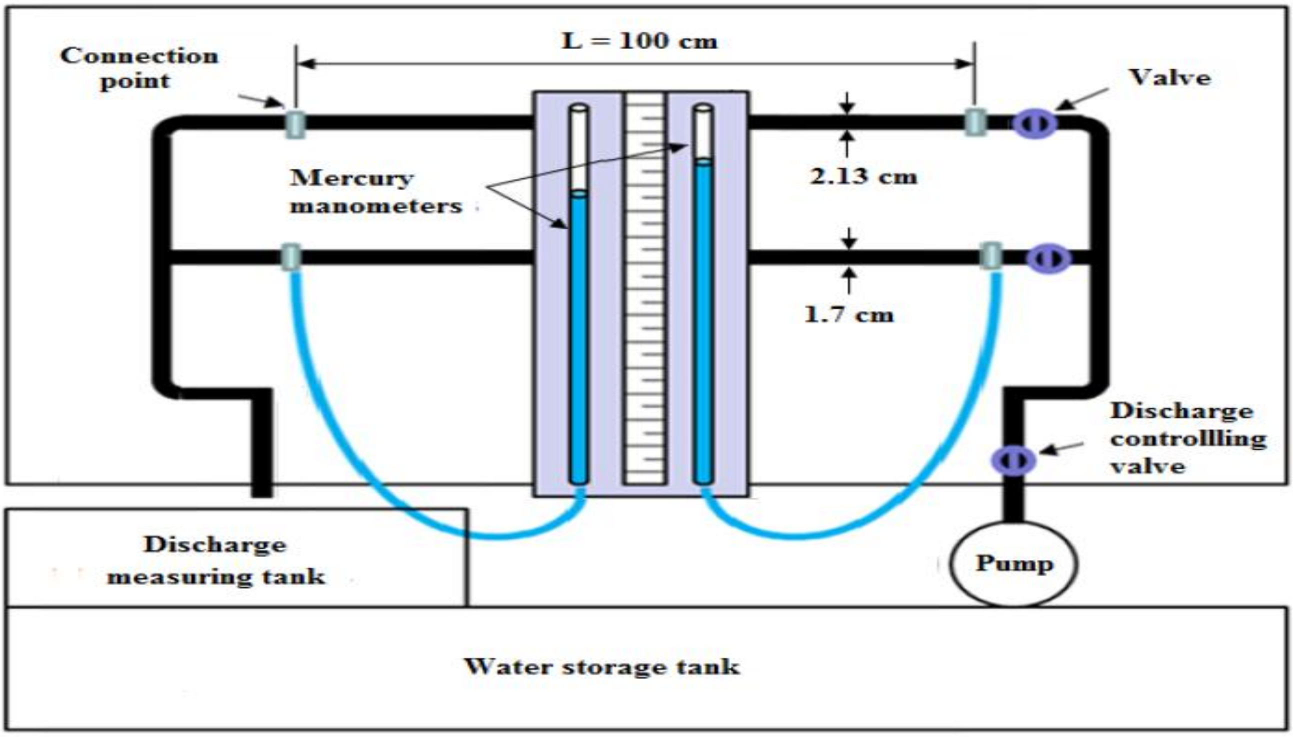
SECOND YEAR

Experiment No.: 6

Name of Experiment: Friction in Pipes.

Objective: To find the friction factor for pipes of different diameters.

Apparatus: 1- Experiment instrument. 2- Thermometer. 3- Stop watch. 4- Discharge measuring tank.



Procedure:

1. Before starting the experiment make sure that the manometer tube is connected to the pipes, and open the two valves of them.
2. Fill the storage tank by water, then switch on the pump to draw water to the network, open the control valve at a discharge just make the manometers at same level.
3. Increase the discharge and read the head in the manometers on the scale board.
4. Measure the actual discharge two trials by the collection tank and stop watch.
5. Take temperature of the water.
6. Repeat the same procedure for each one of the pipes.

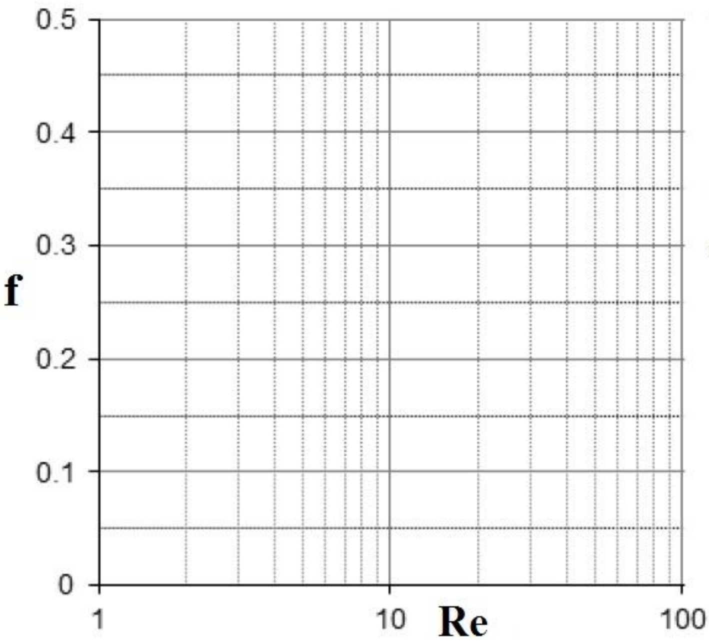
Calculations:

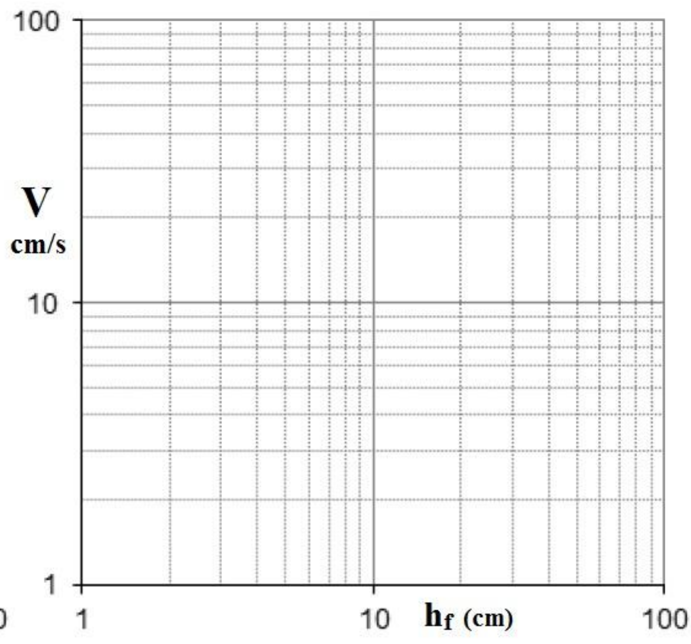
$\Delta h = h_1 - h_2$ $\qquad h_f(\text{water}) = 13.6 * \Delta h\ (\text{mercury})$

$Q = \frac{Vol.}{time}$ $\qquad V = \frac{Q}{A}$

$h_f = \frac{L}{D}\frac{V^2}{2g}f$ $\qquad Re = \frac{VD}{\nu}$

Draw (f versus Re) on semi-log paper and (V versus h_f) on Log-Log paper for each pipe.





)

Kinematic viscosity of water

Temp. C°	ν cm²/sec	Temp. C°	ν cm²/sec	Temp. C°	ν cm²/sec	Temp. C°	ν cm²/sec
10	0.01308	14	0.01172	18	0.01057	22	0.00960
11	0.01271	15	0.01141	19	0.01032	23	0.00936
12	0.01237	16	0.01112	20	0.01007	24	0.00917
13	0.01204	17	0.01048	21	0.00983	25	0.00899

Discussion

1. Discuss the graphs (**f versus Re**) and (**V versus hf**).
2. Numerate some important factors that influence the friction factor (**f**).

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 6

Name of Experiment: Friction in Pipes.

Date of Experiment:

Name of the student:

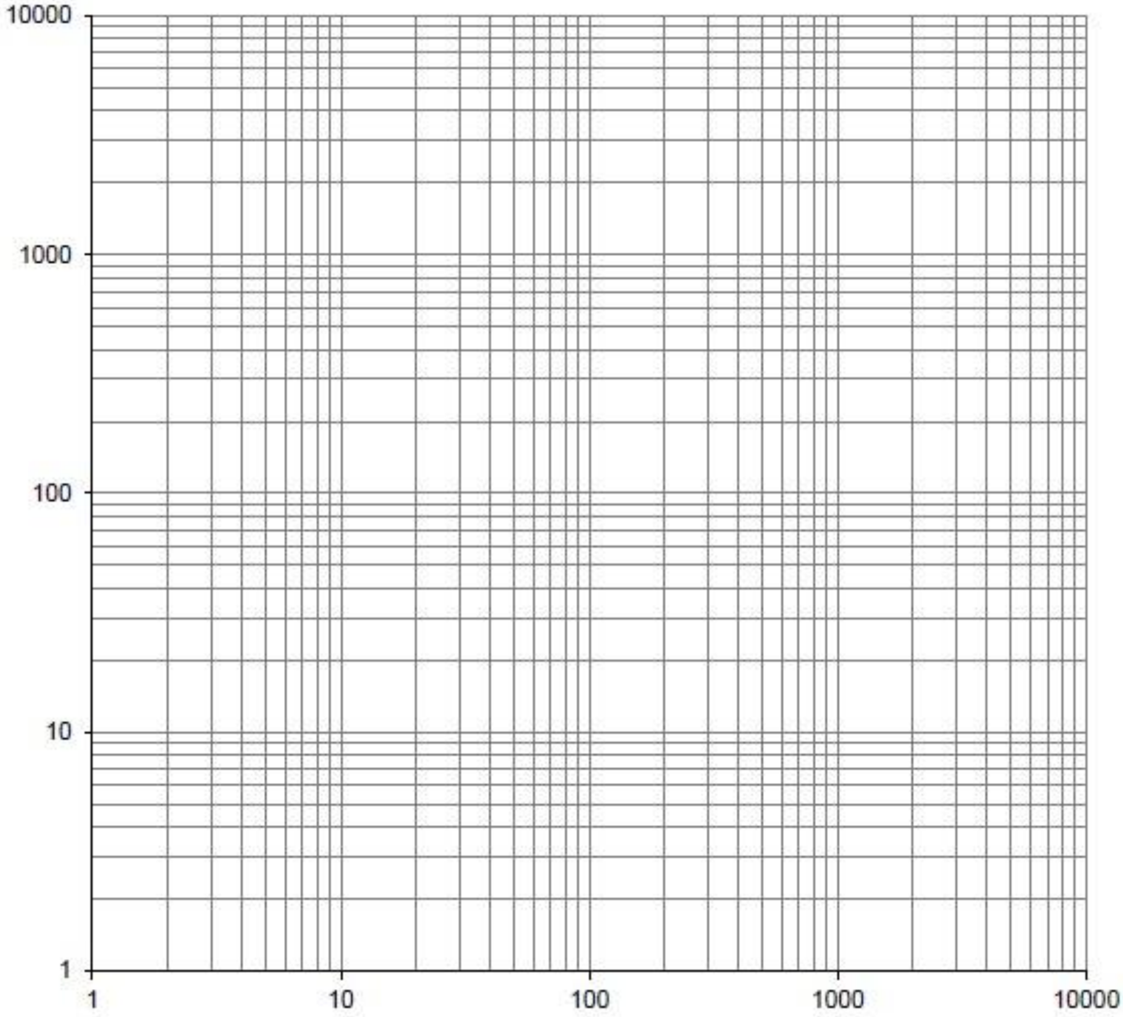
Class: **Group:**

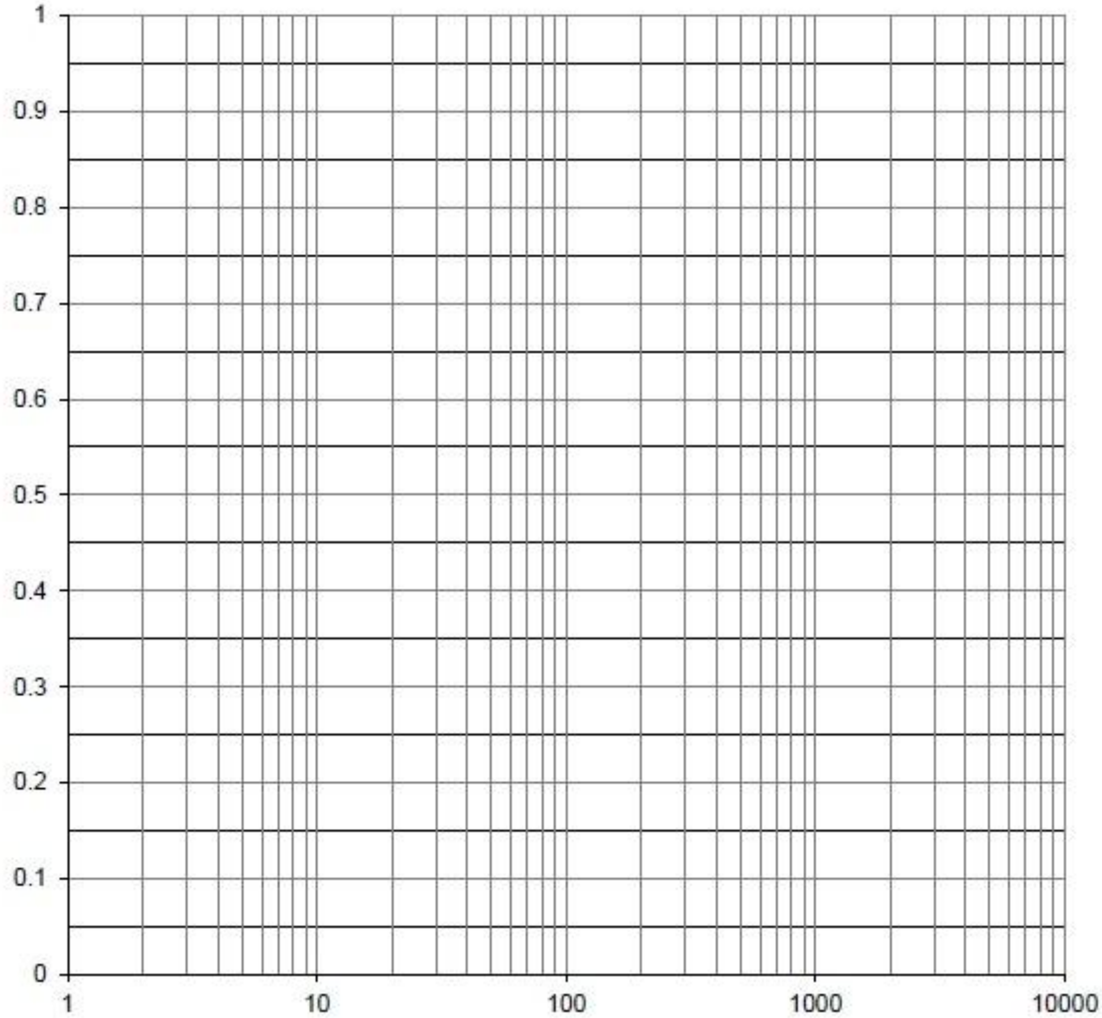
Temperature:

Kinematic Viscosity

D cm	No.	Vol. cm^3	time sec	Q cm^3/s	V cm/sec	h1 cm	h2 cm	dh cm	hf cm	f	Re
2.13	1										
	2										
	3										
	4										
	5										
1.7	1										
	2										
	3										
	4										
	5										

Signature


10000
1000
100
10
1
1
10
100
1000
10000


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
10
100
1000
10000

FLUID MECHANICS LAB

SECOND YEAR

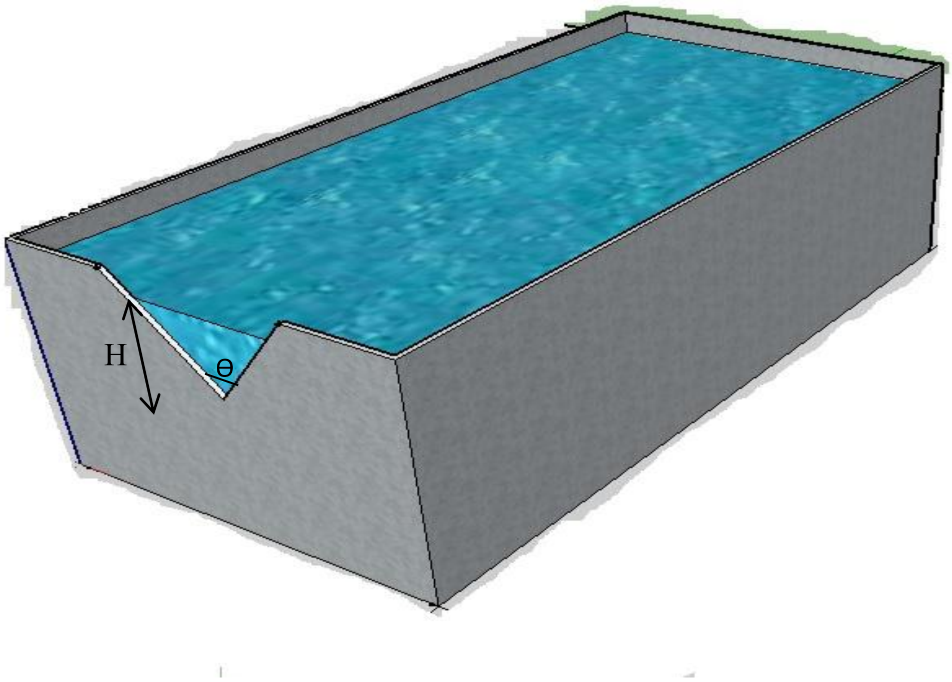
Experiment No.: 7

Name of Experiment: Discharge over V-notch weir

Introduction:
Weir is a hydraulic structure used to regulate water level at upstream and used as a measuring device. According to top width and head over the weir, it can be divided into two main types, sharp crested weir and broad crested weirs.

Objective: To find the discharge coefficient for a V-notch weir.

Apparatus: V- notch weir, water collecting tank and Stop watch.



Procedure:

1. Fill the storage tank by water, switch on the pump to fill the overhead tank by water, wait until the water flows through the over flow pipe.
2. Do the zero setting (of measuring device).
3. Open the control valve to allow flow of the water over the weir.
4. Using the hook pointer measure head of the water above the weir (H).
5. Measure the actual discharge.
6. Repeat the procedure several times increasing the discharge in each time.

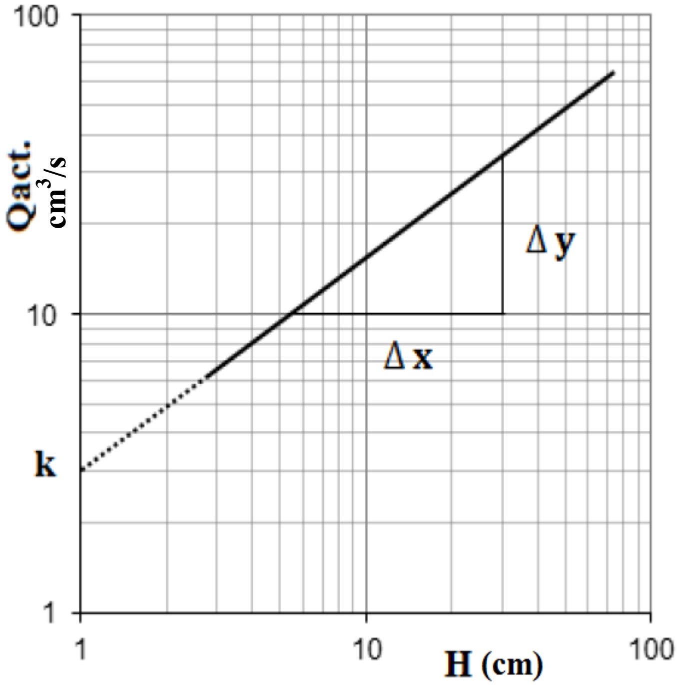
Calculation:

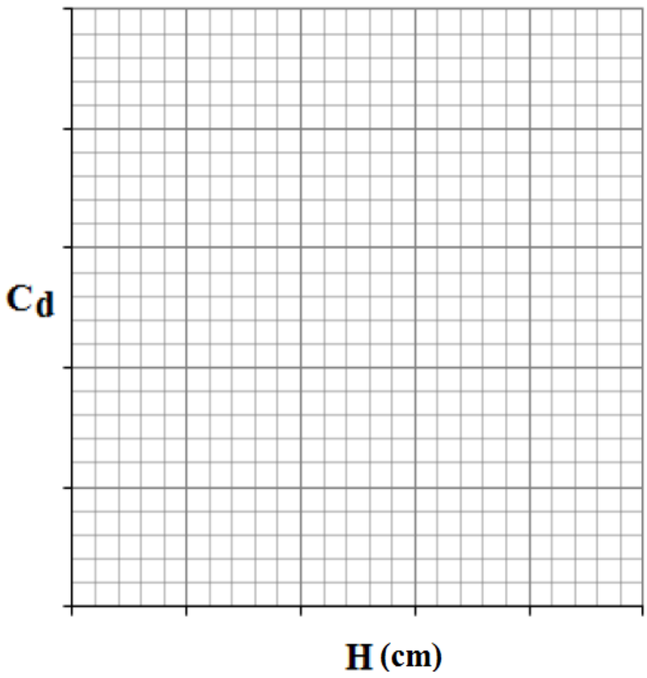
$$Q_{act.} = \frac{Vol.}{time} \qquad Q_{th.} = \frac{8}{15}\sqrt{2g}\tan\left(\frac{\theta}{2}\right)H^{5/2}$$

$$C_d = \frac{Q_{act.}}{Q_{th.}}$$

Plot the following graphs:

1. (Qact) versus (H) on log-log paper and drive an equation for Qact from the relation.
2. Plot (Cd) versus (H).





$$n = slope = \frac{\Delta y}{\Delta x} \qquad n = \frac{\log(y_2) - \log(y_1)}{\log(x_2) - \log(x_1)}$$

$$Q_{act.} = kH^n$$

Discusssion:

1. Discuss both graphs (Qact) versus (H) and (C_d) versus (H).
2. What are the applications of this experiment?
3. What are the most important factors that influence C_d?
4. What is the benefits of V-notch weir compared with rectangular weir?
5. Is the value of C_d increase or decrease with increasing top width of the weir? Discuss it.

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 7

Name of Experiment: Discharge over V-notch weir

Date of Experiment:

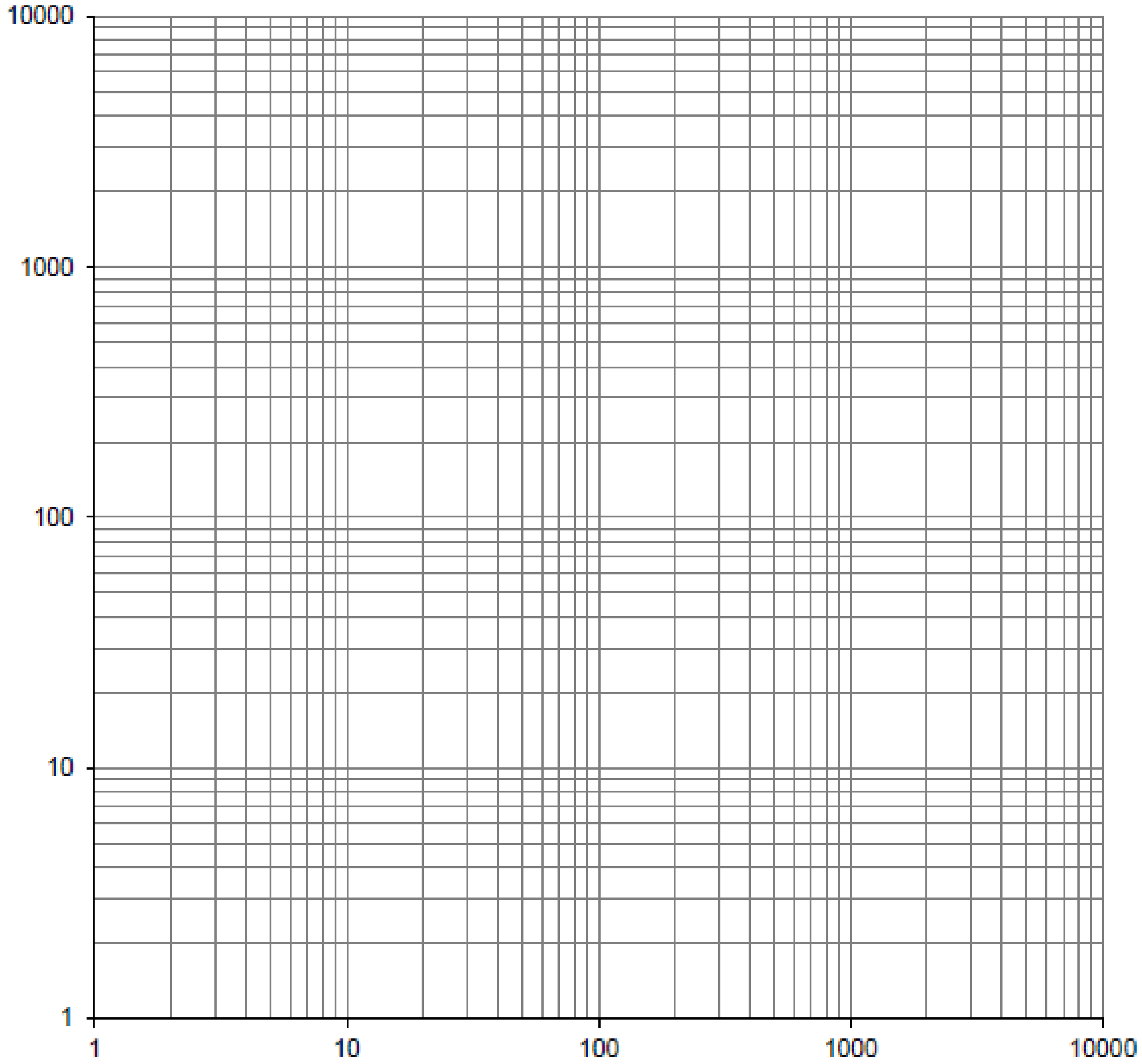
Name of the student:

Class: **Group:**

No.	Vol. cm^3	Time sec	$Q_{act.}$ cm^3/sec	H cm	$Q_{th.}$ cm^3/sec	C_d
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Signature

Prepared by: Yaseen W. Aziz



FLUID MECHANICS LAB

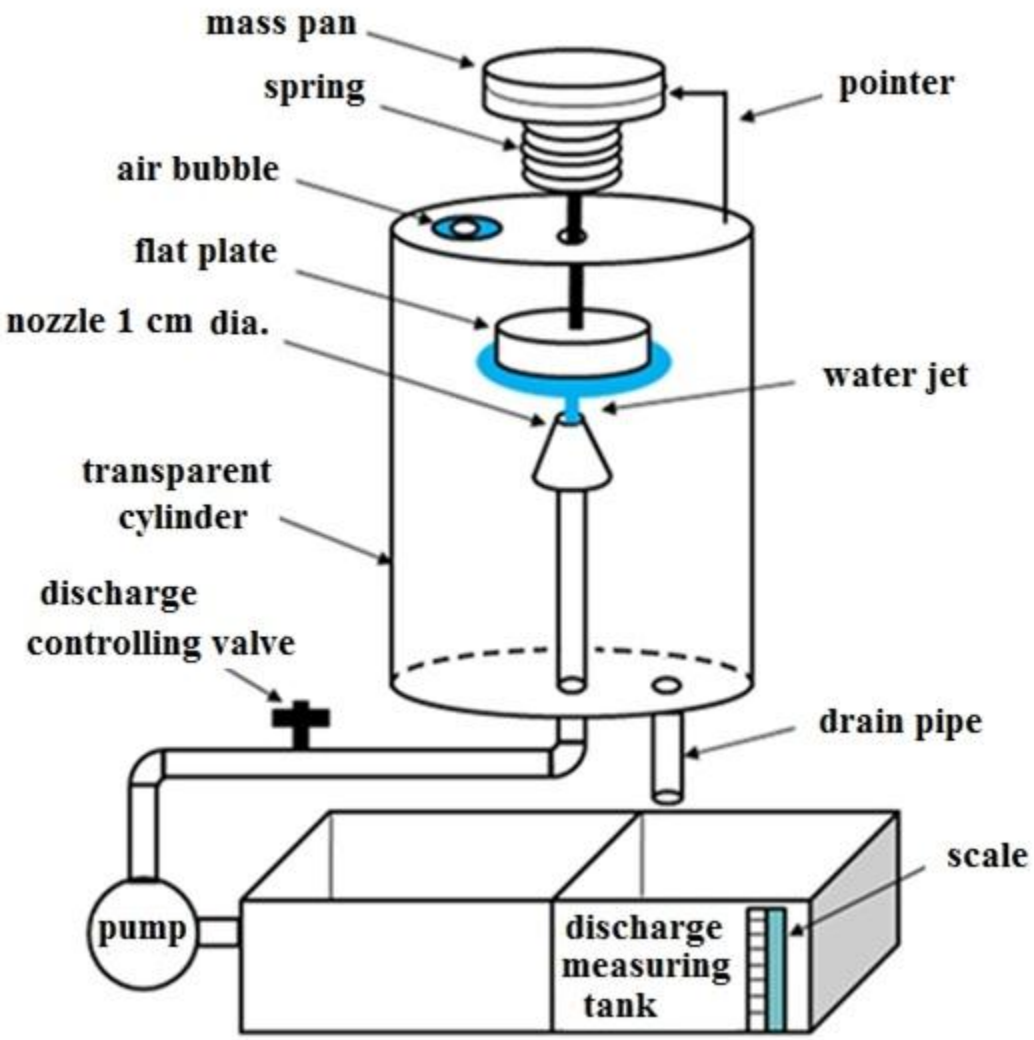
SECOND YEAR

Experiment No.: 8

Name of Experiment: Impact of Jet

Objective: To investigate jet forces impact against stationary deflector.

Apparatus: 1- Experiment instrument. 2- Weights. 3- Stop watch.



Procedure:

1. Adjust the instrument to bring the bubble to the center
2. Place a definite mass (30 – 40 gm) on the scale pan of the instrument.
3. Switch on the pump to draw water from the tank to the instrument.
4. Open the discharge valve to make the water jet balance the placed mass.
5. By the stop watch record the time of collecting a definite volume of water in the collecting tank to obtaining the actual discharge.
6. Repeat steps (2 – 5) several times increasing the mass in each run.

Calculation

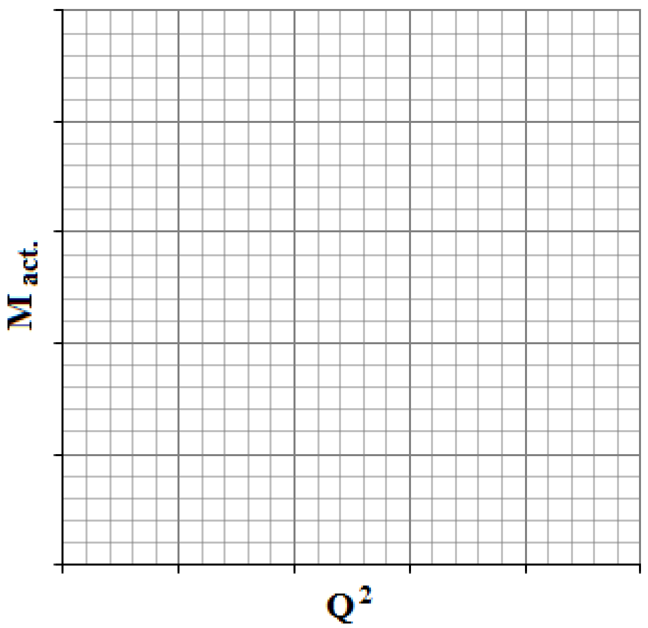
$Q = \frac{\text{Vol.}}{\text{time}}$

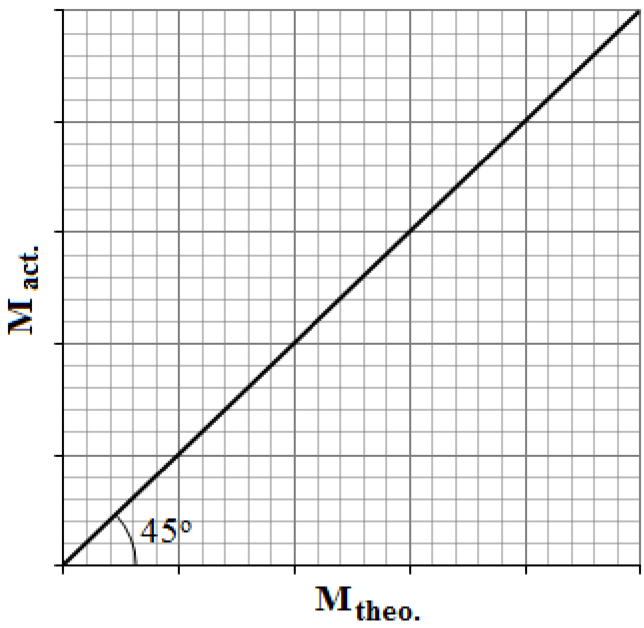
$A = \frac{\pi}{4} d^2$ where d is the nozzle diameter (1 cm)

$M_{th.} = \frac{\rho \, . \, Q^2}{g \, A}$ where ρ is the mass density of water

Draw the following graphs:

1. $\boldsymbol{M_{act.}}$ Versus $\mathbf{Q^2}$ 2. $\boldsymbol{M_{act.}}$ Versus $\boldsymbol{M_{th.}}$ (on ordinary graph paper).





Discussion:

1. Explain sources of error during the experiment.
2. What shape of plates will be used in practice? Why?
3. What is the application of this experiment?

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 8

Name of Experiment: Impact of Jet

Date of Experiment:

Name of the student:

Class: **Group:**

No.	M_{act} gm	Vol. cm^3	time sec	Q cm^3/sec	Q^2 $(cm^3/sec)^2$	$M_{th.}$ gm
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Signature

FLUID MECHANICS LAB

SECOND YEAR

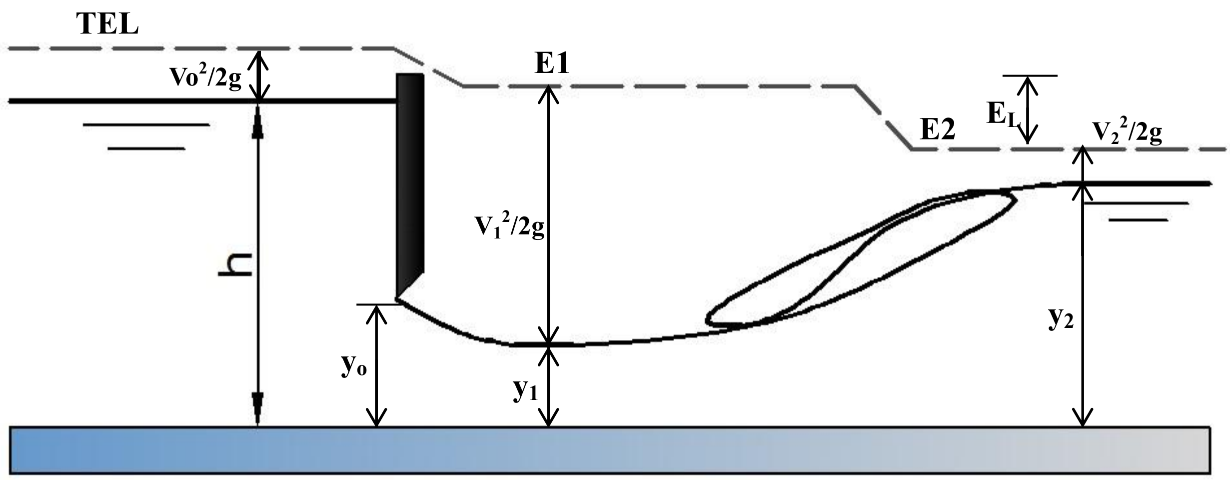
Experiment No.: 9

Name of Experiment: Hydraulic Jump

Introduction:
A hydraulic jump is a complex phenomenon mainly occurs when a supercritical stream meets a subcritical stream. A hydraulic jump primarily serves as an energy dissipator to dissipate the excess energy of flowing water downstream of hydraulic structures, such as spillways and sluice gates.

Objective: To find the energy dissipated through a hydraulic jump

Apparatus: Flume, gate and point gauge.



Procedure:

1. Switch on the pump to fill the overhead tank by water, wait until the water flowing through the Flume become a steady condition.
2. Open the control valve of the sluice gate at defined gate opening to allow flowing of water under the gate.
3. Using the hook pointer measure head of the water above the V notch weir (H) then with k and n determine the actual discharge passes over the weir.

4. Measure the water depth after the gate opening (y1) and the sequence depth (y2).
5. Repeat the same procedure several times by decreasing the gate opining in each time.

Calculation

$Q_{act.} = k\,H^n$ $\qquad V_1 = \frac{Q_{act.}}{b\,.\,y_1}$ ➡ b = 50 cm (width of the flume)

$Fr_1 = \frac{V_1}{\sqrt{g\,y_1}}$

$y_2 = \frac{y_1}{2}\left(\sqrt{1 + 8{Fr_1}^2} - 1\right)$

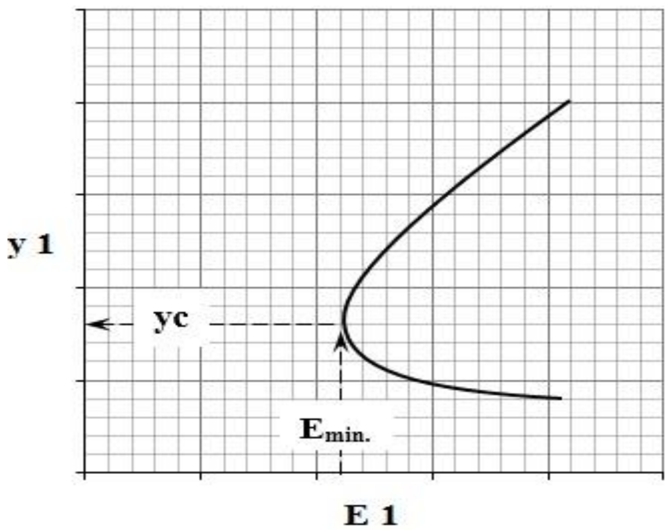
$y_c = \sqrt[3]{\frac{(Q/b)^2}{g}}$ (Critical depth for rectangular channel)

$E1 = y_1 + \frac{{V_1}^2}{2g}$ $\qquad E2 = y_2 + \frac{{V_2}^2}{2g}$

Where E1 and E2 are specific energy at initial depth (y_1) and sequent depth (y_2)

$E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$, E_L is the energy loss due to the hydraulic jump.

plot (y_1) versus E, then find y for minimum E from the graph.



Discussion:

1. Discuss the graph y_1 versus E.
2. Discuss the difference between y_c and flow depth (y) that calculated from minimum E (if any).
3. What are the applications of this experiment?
4. discuss differences between calculated and observed sequent depth (y_2)
5. Is the energy loss increase with increasing discharge intensity? Explain.

FLUID MECHANICS LAB

SECOND YEAR

Data sheet

Experiment No.: 9

Name of Experiment: Hydraulic Jump

Date of Experiment:

Name of the student:

Class: **Group**

k= 0.0195	**n= 2.398**	**h= cm**	**Q= cm^3/sec**	**y_c = cm**

No.	y_1 cm	V_1 cm/sec	E1 cm	Fr_1	Measured (y_2) cm	Calculated (y_2) cm	E_L
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Signature