QMP7.1 D/F

Channabasaveshwara Institute of Technology

(Affiliated to VTU, Belgaum & Approved by AICTE, New Delhi)

(**NAAC Accredited & ISO 9001:2015 Certified Institution)**

NH 206 (B.H. Road), Gubbi, Tumkur – 572 216. Karnataka.

Department of Civil Engineering

FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY

21CV42

B.E - IV Semester

Lab Manual 2022-2023

Name :______________________________________

USN :_______________________________________

Batch :__________________Section :_____________

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Department of Civil Engineering

FLUID MECHANICS AND HYDRULIC MACHINES LABORATORY

21CV42

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Dept. of Civil Engg

Course objectives: Make the students to learn

1Fundamentals of fluid pressure and Hydrostatic laws

2 Principles of Kinematics, Hydrodynamics and basic design of pipes

3 Flow measurements

4Design of open channels and energy concepts

5.Working principles of the hydraulic machines

Course outcome: (Course Skill Set)

At the end of the course the student will be able to :

1. Understand fundamental properties of fluids and solve problems on Hydrostatics
2. Apply Principles of Mathematics to represent Kinematics and Bernoulli's principles
3. Compute discharge through pipes, notches and weirs
4. Design of open channels of various cross sections
5. Design of turbines for the given data and understand their operation characteristics

Reference Books:

1. Sarbjit Singh , *Experiments in Fluid Mechanics* - PHI Pvt. Ltd.- New Delhi
2. Mohd. Kaleem Khan, "Fluid Mechanics and Machinery", Oxford University Press
3.Hydraulics and Fluid Mechanics' – Dr. P.N. Modi & Dr S.M. Seth, Standard Book House- New Delhi. 2009 Edition

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DEPARTMENT OF CIVIL ENGG.

FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY

Subject Code: **21CV42**

No. of Practical Hours/Week: 02T:02L:02P

1. Verification of Bernoulli's equation
2. Determination of Cd for Venturimeter and Orifice meter
3. Determination of hydraulic coefficients of small vertical orifice.
4. Determination of Cd for Rectangular and Triangular notch.
5. Determination of Cd for Ogee and Broad crested weir .
6. Determination of Cd for Venturiflume .
7. Determination of force exerted by a jet on flat and curved plates.
8. Determination of efficiency of Pelton wheel turbine.
9. Determination of efficiency of Francis turbine
10. Determination of efficiency of Kaplan turbine
11. Determination of efficiency of centrifugal pump.
12. Determination of Major in Pipes
13. Determination of Minor losses in pipes due to sudden enlargement, sudden contraction and bend

DEPARTMENT OF CIVIL ENGINEERING

General Instructions

• Laboratory uniform and shoes are compulsory in the lab.

• Do not touch anything with which you are not completely familiar. Carelessness may not only break the valuable equipment in the lab but may also cause serious injury to you and others in the lab.

• Please follow instructions precisely as instructed by your supervisor. Do not start the experiment unless your setup is verified & approved by your supervisor.

• Do not leave the experiments unattended while in progress.

• Do not crowd around the equipment's & run inside the laboratory.

• If any part of the equipment fails while being used, report it immediately to your supervisor. Never try to fix the problem yourself because you could further damage the equipment and harm yourself and others in the lab.

• Keep the work area clear of all materials except those needed for your work and cleanup after your work.

• Switch off the power when equipments are not in use and after the experiments are conducted.

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DEPARTMENT OF CIVIL ENGINEERING

CONTENTS

INDEX PAGE

SL NO	NAME OF THE EXPERIMENT	DATE		OBSERVATION MARKS	RECORD MARKS	STUDENT SIGNATURE	FACULTY SIGNATURE
		CONDUCTION	SUBMISSION				
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
AVERAGE							

Note: If the student fails to attend the regular lab, the experiment has to be completed in the same week. Then the manual/observation and record will be evaluated for 50% of maximum marks

OBSERVATIONS AND CALCULATIONS:

1. $Qact = \frac{A\ X\ h}{t}$
2. Cross section area of collecting tank =__________ m^2

TABULAR COLUMN:

Sl No	Head		Time Taken For 5 Cm Rise	Piezometer (static head) in mm											Q_{act} m^3/s
	Tank 1	Tank 2		P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	
1.															
2.															
3.															

TABULAR COLUMN:

Diameter of test section	Area of test section m^2	Velocity of flow for different cross sections V = Q/A (m/s)	Velocity Head $V_h = V^2/2g$ (m)	Total Head E = Ph + Vh
D_1 = 25 mm	A_1	V_1		
D_2 = 22.7 mm	A_2	V_2		
D_3 = 20.4 mm	A_3	V_3		
D_4 = 18.4 mm	A_4	V_4		
D_5 = 15.8 mm	A_5	V_5		
D_6 = 13.5 mm	A_6	V_6		
D_7 = 15.8 mm	A_7	V_7		
D_8 = 18.4 mm	A_8	V_8		
D_9 = 20.4 mm	A_9	V_9		
D_{10} = 22.7 mm	A_{10}	V_{10}		
D_{11} = 25 mm	A_{11}	V_{11}		

Expt. No. 1 **Date: _________**

VERIFICATION OF BERNOULLIS EQUATION

Aim: To verify Bernoulli's Theorem

Apparatus: Bernoulli's experimental set up, stop clock

Theory: The Bernoulli's theorem states that for a perfect incompressible liquid flowing in pipe line the total energy of a particle remains constant while the particle moves from one point to another, assuming that there are no frictional losses in the pipe line. Mathematically Bernoulli's theorem states,

$$z + \frac{V^2}{2g} + \frac{P}{W} = Constant$$

Procedure:

1. Switch on the pump.
2. Partially close the "by pass" valve, water flows into the supply tank.
3. As the water level rises in the supply tank water starts flowing into the reservoir tank through the venture test section and the water level in the receiving tank also rises.
4. When the water level in both the tank reaches their respective over flow level, control the "by pass" valve.
5. Allow the water flow to become steady.
6. Record the readings of peizometer and the flow rate from the receiving tank against time by closing the outlet valve of measuring tank for 5cm rise of water level.
7. Repeat the experiment for different discharge.
8. Tabulate all the readings and calculate to verify Bernoulli's theorem.

Result:

TABULAR COLUMN:

Sl no	Manometer reading (cm)			Head of water $H = \frac{12.6h}{1000}$ (m)	Time taken to collect __ m of water in (R in sec)	Actual Discharge Qact (m3/s)	Theoretical discharge Qthe (m^3/s)	$C_d = Q_{act}/Q_{the}$
	h_1	h_2	$h=h_1-h_2$					

OBSERVATION & CALCULATIONS:

1. Area of collecting tank, A=_____________ m^2
2. Acceleration due to gravity, g= 9.81 m/s^2
3. Dia. of venturi meter (throat), dv = __________mm, _______m
4. Dia. of venturi meter (inlet), Dv = __________mm, _______m

$$Q_{th} = \frac{a_1 a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}}$$

Where:

$a_1 = \frac{\pi D_v^2}{4}$ = __________m^2 and $a_2 = \frac{\pi d_v^2}{4}$ = _________ m^2

H = head loss = 12.6h meters
h = differential monometer head in mm of Hg

Actual Discharge,

$$Q_{act} = \frac{AR}{T} \quad m^3/s$$

Where A = area of collecting tank in meters
R = rise of water level in the collecting tank in meters
T = time taken to rise (R) of water in the collecting tank

Expt. No. 2 **Date: _________**

VENTURIMETER

Aim: To determine the co-efficient of discharge through Venturimeter.

Theory: Venturimeter is a device used to measure discharge of fluid in a closed conduit or pipeline. It consists of a convergent cone, throat and divergent cone. As the area of the flow decreases in the convergent cone, velocity of flow increases and pressure decreases. The measurement of pressure difference between the inlet section and throat section leads to the measurement of discharge. The angle of divergent cone will be 600 and that of convergent cone will be about 200. The length of the divergent cone will be more than the length of convergent cone. The dia of the throat will be 0.5-0.6 times the dia of the pipeline or the inlet section. If a fluid is made to flow through a varying section due to the variation in pressure, there will be variation in velocity and this effect is known as venture effect.

Apparatus used:

1. Venturimeter
2. Pump and motor for steady supply of water.
3. Clock to record the time
4. Measuring tank

Procedure:

1. Fill the sump with clean water. Keep the delivery valve closed. Open the ball valve of the venturimeter pipeline.
2. Adjust the flow through the control valve of pump.
3. Open the corresponding ball valve fitted to Venturi meter tank tapping.
4. Care should be taken, such that there should be not any air bubble, while the liquid is passing through the manometer.
5. The differential reading of the manometer is noted down from the level of Hg in two limbs.
6. Then the time required to collect 200 mm of water in the collecting tank is noted down.
7. Finally the procedure is employed for different discharge through the pipeline.

Graph to be plotted

Log Q_{act} Vs logh and calculate the slope

Result: Coefficient of discharge C_d of Venturimeter =

TABULAR COLUMN:

Sl no	Manometer reading (cm)			Head of water $H = \frac{12.6h}{1000}$ (m)	Time taken to collect __ m of water in (R in sec)	Actual Discharge Qact (m3/s)	Theoretical discharge Qthe (m^3/s)	$C_d = Q_{act}/Q_{the}$
	h_1	h_2	$h=h_1-h_2$					

OBSERVATION & CALCULATIONS:

1. Area of collecting tank, A=_____________ m^2
2. Acceleration due to gravity, g= 9.81 m/s^2
3. Dia. of orifice meter (inlet), di = __________mm, _______m
4. Dia. of orifice meter (outlet), Do = ___________mm, _______m

$$Q_{th} = \frac{a_1 a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}}$$

Where:

$a_1 = \frac{\pi D_0^2}{4}$ = _________m^2 and $a_2 = \frac{\pi d_0^2}{4}$ =___________m^2

H = head loss = 12.6h meters
h = differential monometer head in mm of Hg

Actual Discharge,

$$Q_{act} = \frac{AR}{T} \quad m^3/s$$

Where A = area of collecting tank in meters
R = rise of water level in the collecting tank in meters
T = time taken to rise (R) of water in the collecting tank

Expt. No. 3 **Date: __________**

ORIFICEMETER

Aim: To determine the co-efficient of discharge through Orificemeter

Theory: An orifice meter is another simple device used for measuring the discharge through pipes, orifice meter also works on the same principle as that of venturimeter. i.e., by reducing the cross-sectional area of the flow passage, a pressure difference between the two sections before and after orifice is developed and the measurement of pressure difference enables the determination of the discharge through pipes. However, an orifice meter is a cheaper arrangement for discharge measurement through pipes and its installation requires a smaller length as compared with venture meter. As such where the space is limited, the orifice meter may be used for the measurement of discharge through pipes.

Apparatus used:

1. Orificemeter
2. Pump and motor for steady supply of water.
3. Clock to record the time
4. Measuring tank

Procedure:

1. Fill the sump with clean water. Keep the delivery valve closed. Open the ball valve of the venturimeter pipeline.
2. Adjust the flow through the control valve of pump.
3. Open the corresponding ball valve fitted to Venturi meter tank tapping.
4. Care should be taken, such that there should be not any air bubble, while the liquid is passing through the manometer.
5. The differential reading of the manometer is noted down from the level of Hg in two limbs.
6. Then the time required to collect 200 mm of water in the collecting tank is noted down.
7. Finally the procedure is employed for different discharge through the pipeline.

Graph to be plotted

Log Q_{act} Vs logh and calculate the slope

Result: Coefficient of discharge C_d of Orificemeter =

TABULAR COLUMN:

Area of collecting tank , A = ___________m

Rise in the water level R = _______________m

Time taken for R = _____________________s

Sl. No	Head over the orifice h(m)	Actual discharge $Q_{act} = \frac{AR}{T}$ (m^3/sec)	Theoretical discharge $Q_{th}=a\sqrt{2gh}$ (m^3/sec)	Horizontal co-ordinate x (cm)	Vertical co-ordinate y(cm)	Coeft. of discharge C_d	Coeft. of velocity C_v	Coeft. of contraction C_c	Coeft. of resista C_r

OBSERVATION & CALCULATIONS:

Area of Orifice =

Coefficient of discharge, $C_d = \frac{Q_{act}}{Q_{th}} =$

Coefficient of velocity, $C_v = \sqrt{\frac{x^2}{4yh}}$

Coefficient of contraction, $C_r = \left(\frac{1}{C_v^2} - 1\right)$

Expt. No. 4 **Date: _________**

VERTICAL ORIFICE

Aim: To determine the hydraulic coefficients C_d, C_v, C_c, and C_r for a given orifice or a mouthpiece.

Theory: Orifice is a small opening of any cross section (such as circular, triangular and rectangular etc) on the side or at the bottom of a tank, through which a fluid is flowing. Orifices are used to measure the rate of flow of fluid.

Apparatus required:

1. Experimental setup of orifices,
2. Points gauge
3. Stop watch
4. Measuring tank
5. Scale and Vernier calipers.

Procedure:

1. By using slide calipers, find out the diameter of the given orifice or a mouthpiece.
2. Note down the dimensions of the measuring tank.
3. By operating the inlet valve, maintain a constant head (h) over the orifice.
4. Note down the required to collect 5 cm rise of water in the collecting tank.
5. By using point gauge measure the x and y co-ordinates from vena-contracta section.
6. Repeat the steps 4 & 5 by varying the head over the orifice or a mouthpiece.

TABULAR COLUMN:

1. **Area of measuring tank A = ___________ m^2**
2. **Head of water collected in measuring tank R = ________m**

Sl No	Head Over 90° V-Notch			Time taken for 5 cm rise of water in measuring tank 't' sec	$Qact = \frac{AR}{t}$ m^3/s	Qthe m^3/s	$Cd = \frac{Qact}{Qthe}$
	Final hook gauge reading h_2	Initial hook gauge reading h_1	$H = h_2 - h_1$				
1							
2							
3							

OBSERVATION & CALCULATION:

1. $Q\,the = \frac{8}{15} X \tan\frac{\theta}{2} X\ H^{\frac{5}{2}} X \sqrt{2g}$

Expt. No. 5 **Date: _________**

CALIBRATION OF 90˚ V-NOTCH

Aim of the experiment: To determine the coefficient of discharge C_d, constant K & the index N for the given notch.

Theory: A notch may be defined as an overflow opening provided in the side of a tank or a small channel such that the liquid surface in the tank or channel is below the top edge of the Opening. Notches are usually used in narrow channels in order to measure the small charges accurately.

Notches are classified according to the shape of the opening as rectangular notch, triangular notch (or v-notch), trapezoidal notch, parabolic notch, stepped notch etc. Notches may also be classified according to the effect of the nappe emerging from a notch, as a notch with end contractions and a notch without end contractions or suppressed notch.

A Triangular notch may be further classified as 90^0 V-notch and 60^0 V-notch depending upon the angle between the two sloping sides.

Cipolletti notch is a specific type of Trapezoidal notch, with side slopes of 1 horizontal to 4 vertical i.e. $\theta/2 = 14^0 2'$.

Apparatus required:

1. Hook gauge
2. 90^o V-notch
3. Scale &
4. Stop watch.

Procedure:

1. Note down the least count of the hook gauge.
2. Measure the dimensions of the measuring tank.
3. Maintain the water level just at the sill of the notch and note down the no-flow head over the notch (initial level of hook gauge) by using the hook gauge.
4. By operating the control valve at the upstream side of the notch slowly increase the head over the notch & when flow becomes steady note down the final reading of the hook gauge.
5. Note down the time in seconds required to collect 5 cm of water, in the measuring tank
6. Repeat the steps 4 & 5 for 5 or 6 times.
7. Tabulate the readings as shown in the table.
8. Draw a curve of Q v/s H on a log-log graph.
9. Determine the value of C_d & N.

Result: Coefficient of discharge of 90˚ V notch =

TABULAR COLUMN:

1. **Area of measuring tank A = ___________ m^2**
2. **Head of water collected in measuring tank R = _________m**
3. **Length of the notch at sill level (L) = _____________m**

Sl No	Head Over 90˚ V-Notch			Time taken for 5 cm rise of water in measuring tank 't' sec	$Qact = \frac{AR}{t}$ m^3/s	Qthe m^3/s	$Cd = \frac{Qact}{Qthe}$
	Final hook gauge reading h_2	Initial hook gauge reading h_1	$H = h_2 - h_1$				
1							
2							
3							

OBSERVATION & CALCULATION:

$$1.\ Q\ the = \frac{2}{3}\ X\ H^{\frac{3}{2}} X\ L\ X \sqrt{2g}$$

Expt. No. 6 **Date: __________**

CALIBRATION OF RECTANGULAR NOTCH

Aim of the experiment: To determine the coefficient of discharge C_d, constant K & the index N for the given notch.

Apparatus required:

1. Hook gauge
2. Rectangular notch
3. Scale &
4. Stop watch.

Procedure:

1. Note down the least count of the hook gauge.
2. Measure the dimensions of the measuring tank.
3. Maintain the water level just at the sill of the notch and note down the no-flow head over the notch (initial level of hook gauge) by using the hook gauge.
4. By operating the control valve at the upstream side of the notch slowly increase the head over the notch & when flow becomes steady note down the final reading of the hook gauge.
5. Note down the time in seconds required to collect 5 cm of water, in the measuring tank
6. Repeat the steps 4 & 5 for 5 or 6 times.
7. Tabulate the readings as shown in the table.
8. Draw a curve of Q v/s H on a log-log graph.
4. Determine the value of C_d & N.

Result:

Coefficient of discharge of Rectangular notch =

TABULAR COLUMN:

Sl no	Final hook gauge reading (mm)	Initial hook gauge reading (mm)	Difference of hook gauge reading (mm)	Q_{act}		Q_{the}	$C_d = \frac{Q_{act}}{Q_{the}}$
				lpm	m^3/s		
1.							
2.							
3.							

OBSERVATIONS AND CALCULATIONS:

1. $Q_{the} = \frac{2}{3}\, b\, H^{\frac{3}{2}} \sqrt{2g}$

Where H = head over the notch in m

b = width of weir

g = acceleration due to gravity (9.81 m/s^2)

Expt. No. 7 **Date: _________**

CALIBRATION OF OGEE WEIR

Aim of the experiment: To determine the coefficient of discharge C_d, constant K & the index N for the given weir.

Theory: A weir is a concrete or masonry barrier built across a river or a stream to store the water and surpass the excess of water above full reservoir level. Weirs are also used to measure the discharges of water in a river or a stream. Weirs may be classified according to the geometry of the opening, the dimensions of the crest, the effect of discharge due to the nappe and the tail water conditions. According to the geometry of the opening, the weirs may be classified as rectangular, triangular and trapezoidal weirs. Cipolletti weir is a trapezoidal weir having side slopes of 1(H) to 4(V).According to the dimensions of the crest, the weirs may be classified as sharp crested weir and Broad crested weir. Weirs may also be classified as suppressed and non-suppressed weirs. Depending on the tail water levels, weirs may be classified as freely discharging weir and submerged weir. The broad crested weir and ogee weir are being extensively used; hence the calibration of these two weirs is explained. A weir having a wide crest is known as Broad crested weir. Such a weir differs from a narrow or sharp crested weir. In case of sharp crested weir the jet of water touches only the upstream edge of the weir and behaves like a notch while in broad crested weir the sheet of water completely rests over weir. Experiments have shown that if the width of the crest of the weir (B) is less than 0.5H (head over the crest) then the jet of water touches only the upstream edge of the weir and it flows clear of the weir (B) is greater than 0.5H then it behaves as a Broad crested weir.

Apparatus required:

1. Hook gauges
2. Ogee weir.

Procedure:

1. Note down the least counts of the hook gauges near 90˚ v-notch & broad crested weir.
2. Maintain the water level just at the sill of the notch and the weir and note down the no-flow head over the notch and the weir (initial level of hook gauge) by using the hook gauges.
3. By operating the control valve at the upstream side of the notches slowly increase the head over the notch and the weir & when flow becomes steady note down the final readings of the hook gauges.
4. Repeat the step 3 for 5 or 6 times.
5. Tabulate the readings as shown in the table.
6. Draw a curve of Q v/s H on a log-log graph.
7. Determine the value of C_d & N.

Result: Co-efficient of discharge Cd =

TABULAR COLUMN:

Sl no	Final hook gauge reading (mm)	Initial hook gauge reading (mm)	Difference of hook gauge reading (mm)	Q_{act}		Q_{the}	$C_d = \frac{Q_{act}}{Q_{the}}$
				lpm	m^3/s		
1.							
2.							
3.							

OBSERVATIONS AND CALCULATIONS:

1. $Q_{the} = \frac{2}{3} b H^{\frac{3}{2}} \sqrt{2g}$

Where H = head over the notch in m

b = width of weir

g = acceleration due to gravity ($9.81\ m/s^2$)

Expt. No. 8 **Date: ________**

CALIBRATION OF BROAD CRESTED WEIR

Aim of the experiment: To determine the coefficient of discharge C_d, constant K & the index N for the given weir.

Apparatus required:

1. Hook gauges
2. Broad crested weir.

Procedure:

1. Note down the least counts of the hook gauges near 900 v-notch & broad crested weir.
2. Maintain the water level just at the sill of the notch and the weir and note down the no-flow head over the notch and the weir (initial level of hook gauge) by using the hook gauges.
3. By operating the control valve at the upstream side of the notches slowly increase the head over the notch and the weir & when flow becomes steady note down the final readings of the hook gauges.
4. Repeat the step 3 for 5 or 6 times.
5. Tabulate the readings as shown in the table.
6. Draw a curve of Q v/s H on a log-log graph.
7. Determine the value of C_d & N.

Result: Co-efficient of discharge Cd =

TABULAR COLUMN:

Sl no	Head at approach			Head at throat			Q_{act} m^3/s
	Final hook gauge reading (cm)	Initial hook gauge reading (cm)	Difference H (m)	Final hook gauge reading (cm)	Initial hook gauge reading (cm)	Difference H (m)	

OBSERVATIONS AND CALCULATIONS:

$$Q_{the} = \frac{A_1 A_2 \sqrt{2gH}}{\sqrt{A1^2 - A2^2}}$$

Where A1 = Inlet Area
A2 = Outlet area

Expt. No. 9 **Date: _________**

CALIBRATION OF VENTURIFLUME

Aim of the experiment: To determine the coefficient of discharge C_d constant K & the index N.

Theory: Venturiflume is a metering device used for the measurement of rate of flow in open channel. The basic principle on which the venturiflume works is same as that of an venturimeter.

The main parts of the venturiflume are: inlet section, convergent section, throat and divergent section. The inlet section is same as that of the approach channel. The convergent section tapers from inlet section to the throat. Divergent section is relatively large, whose cross sectional area is gradually increases from throat to the original size of the channel. In the convergent section the velocity gradually increases from inlet section to the throat and the pressure head decreases from inlet to the throat, in order to satisfy Bernoulli's theorem. The pressure head difference is made use for the measurement of discharges. It is to be noted that only the inlet section and the throat is used for metering purpose and not the throat and the divergent section.

Apparatus required:

1. Venturiflume experimental setup
2. Stop watch
3. Measuring tank
4. Scale

Experimental procedure:

1. Note down the dimensions of the measuring tank.
2. Measure the width of the approach channel and throat by using a scale.
3. By operating the inlet valve adjust the flow through the venturiflume.
4. Note down the head differences at the approach channel and the throat by using hook gauges.
5. By using a stop watch, register the time taken in seconds to collect 5 cm rise of water in the measuring tank.
6. Repeat the steps 4 & 5 for 5 or 6 times by increasing the discharge through he venturiflume each time.
7. Draw a graph of Q v/s H on a log log scale.
8. Calculate the values of Cd & N.

TABULAR COLUMN:

Type of vane	Dia of Jet D (m)	Q m3/s	Force Indicator F act		F the	$K = \frac{F\ act}{F\ the}$
			Kgf	N		
Hemispherical						
Flat						
Inclined						

OBSERVATIONS AND CALCULATIONS:

1. Cross section area of jet 'a' =______________m^2
2. Velocity of jet, $V = \frac{Q}{a}$ m/s
3. Theoretical force
   a. Flat plate : $F_{the} = \rho a V^2$ N

   b. Hemispherical plate : $F_{the} = 2\rho a V^2$ N

   c. Inclined plate : $F_{the} = \rho a V^2\ sin\theta^2$ N

Expt. No. 10 **Date: _________**

DETERMINATION OF FORCE EXERTED BY JET ON VANES

Aim of the experiment: To determine the coefficient of impact (C_i) of the jet on the following vanes: Flat vane; Semicircular vane; and inclined vane

Theory : The liquid comes out in the form of a jet from the outlet of a nozzle, which is fitted to a pipe through which the liquid is flowing under pressure. If some plate, which may be fixed or moving, is placed in the path of the jet, the jet on the plate exerts a force. This force is obtained from Newton's second law of motion or from impulse momentum equation. Thus impact of jet means the force excited by the jet on a plate, which may be stationary or moving.

a) Force exerted by the jet on a stationary plate is when,

- Plate is vertical to jet
- plate is inclined to jet
- Plate is curved.

b) Force exerted by the jet on a moving plate is when

- Plate is vertical to jet
- Plate is inclined to jet.
- Plate is curved

Apparatus required:

1. Vanes (flat, inclined with $\theta = 30^0$ and hemispherical),
2. experimental setup comprising rotameter,
3. Nozzles of different diameter
4. steady supply of water using pump

Procedure:

1. Fix the required diameter of nozzle and the vane of the required shape in position.
2. Bring the force indicator position to zero.
3. Keep the delivery valve closed and switch on the pump.
4. Close the front transparent glass tightly.
5. Open the delivery valve and adjust the flow rate.
6. Observe the force as indicated on the force indicator.
7. Note down the diameter of the pipe of the jet and shape of the vane and the discharge is calculated.

SPECIFICATION:

1. Supply pump capacity : 7.5Hp, 3ph, 440V
2. Turbine capacity : 1.1 kW
3. Run away speed : 1500 rpm
4. Loading : Brake drum with spring balance

TABULAR COLUMN:

CONSTANT SPEED

Sl No	Turbine speed 'N' rpm	Pr Gauge reading 'P' Kg/cm^2	Head over turbine 'H' in m	Head over the notch h_2-h_1=h in m	Spring balance reading Kg S_2-S_1= S	Flow rate 'Q' m^3/s	Input power kW	Brake power Bp kW	Turbine efficiency % η_{turb}

CONSTANT HEAD

Sl No	Turbine speed 'N' rpm	Pr Gauge reading 'P' Kg/cm^2	Head over turbine 'H' in m	Head over the notch h_2-h_1=h in m	Spring balance reading Kg S_2-S_1= S	Flow rate 'Q' m^3/s	Input power kW	Brake power Bp kW	Turbine efficiency % η_{turb}

Expt. No. 11 **Date:**

DETERMINATION OF EFFICIENCY OF OF PELTON TURBINE

Aim of the experiment: To study the performance of pelton wheel under varying condition of head, speed and gate opening.

Theory : Pelton wheel is a tangential flow impulse turbine. The powerful jet issued from the nozzle impinges on the buckets provided on the periphery of the wheel. The buckets have the shape of a double semi-ellipsoidal cups. Each bucket is divided into two symmetrical parts by a sharp edged ridge known as splitter.

Procedure:

1. Connect the panel to the electrical source & ascertain the direction of the pump is in order (clock wise direction from shaft end) by momentarily starting the pump.
2. Fill filtered clear water into the sump tank up to ¾th its full capacity
3. Keep the control valve situated above the pump in fully closed position, and the sphere valve in half open position.
4. Start the pump; gradually open the control valve slowly so that the turbine achieves sufficient speed.
5. Wait till the head of the turbine maintained constant.
6. Load the turbine by turning the hand wheel situated on the load frame clock wise observing the dial spring balance to any desired minimum load
7. Allow the turbine speed to stabilize
8. Record the readings indicated on pressure gauge, dial balance RPM indicator and head over the venturimeter.
9. Continue loading the turbine in steps up to its full load and record the corresponding readings at each steps
10. After the experiment is over bring the turbine to no load condition by rotating the hand wheel on the load frame in anti clock wise direction and stop the pump.
11. Tabulate all the recorded readings and calculate the input power, output power & efficiency of

CALCULATIONS:

1. Head on turbine H:
   H = 10 x P where P is the pressure gauge reading in Kg/cm^2

2. Flow rate of water $Q = Cd\ \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2+a_2^2}}$ m^3/s

   $g = 9.81\ m/sec^2$
   $C_d = 0.9$
   b = Width of notch in m
   h = Head over the notch in m

3. Input power = WQH / 1000 kW where W = 9810 N/m^3

4. Brake power
   BP = $2\pi N (S_2-S_1)$ r x 9.81 / 60 x 1000 kW

   Where r = Radius of the brake drum = 0.168 m(0.152+. 016)

5. Turbine efficiency $\eta_{turb} = \frac{BP}{IP}$ X 100

6. Unit speed, $N_u = \frac{N}{\sqrt{H}}$

7. Unit discharge, $Q_u = \frac{Q}{\sqrt{H}}$

8. Unit power, $P_u = \frac{BP}{H^{\frac{3}{2}}}$

9. Specific speed, $N_s = \frac{N\sqrt{BP}}{H^{\frac{5}{4}}}$

Graphs to be plotted:

1. **Main Characteristics Curves (constant Head)**
   - Q_u Vs N_u
   - P_u Vs N_u
   - η_o Vs N_u
2. **Operating Characteristics Curves (Constant Speed)**
   - η_o Vs % full load.

Result: Efficiency of Pelton wheel turbine =

SPECIFICATION:

1. Supply pump capacity : 7.5 Kw (10 Hp) 3ph, 400V
2. Turbine capacity : 2.6 HP (2 Kw)
3. Run away speed : 2000 RPM

TABULAR COLUMN:

CONSTANT HEAD

Sl No	Turbine speed 'N' rpm	Pr Gauge reading 'P' Kg/cm^2	Head over turbine 'H' in m	Manometer reading		Load		Flow rate 'Q' m^3/s	Input power kW	Brake power Bp kW	Turbine efficiency % η_{turb}
				L_1	L_2	Voltage V Volts	Current I Amps				

CONSTANT SPEED

Sl No	Turbine speed 'N' rpm	Pr Gauge reading 'P' Kg/cm^2	Head over turbine 'H' in m	Manometer reading		Load		Flow rate 'Q' m^3/s	Input power kW	Brake power Bp kW	Turbine efficiency % η_{turb}
				L_1	L_2	Voltage V Volts	Current I Amps				

Expt. No. 12 **Date: __________**

DETERMINATION OF EFFICIENCY OF OF KAPLAN TURBINE

Aim of the experiment: To study the performance of pelton wheel under varying condition of head, speed and gate opening.

Procedure: Constant Speed

1. Install the equipment near a 3 phase 440 volts, 50 Hz, 20 amps power source & water source.
2. Connect the panel to the electrical source & ascertain the direction of the pump is in order (clock wise direction from shaft end) by momentarily starting the pump.
3. Fill filtered clear water into the sump tank up to ¾th its full capacity.
4. Keep the gate valve situated above the pump in fully closed position, turbine guide vanes in full open position.
5. Start the pump, gradually open the gate valve slowly so that the turbine achieves sufficient speed to generate around 200 volts on the panel voltmeter.
6. Wait till the speed of the turbine maintained constant.
7. Put on the first electrical load switch and adjust the speed of Turbine to 1600 rpm(can be set to any speed from 1500 to 2000 rpm) on the digital indicator and record the corresponding Ammeter, voltmeter, Pressure gauge & Head over the notch readings.
8. Continue increasing the load on the Turbine step by step by switching ON the consecutive load switches one by one, by gradually opening the Gate valve so that the rpm indicator reading shows 1600 rpm on each step. Record the corresponding readings of Ammeter, Pressure Gauge & Head over the orifice meter.
9. Change the Turbine guide vane to any desired position (between fully open to closed conditions) by operating the hand wheel situated at the rear end of the Turbine to repeat the experiment on varied condition by following steps 7 & 8.
10. After the experiment is over bring the turbine to no load condition by switching OFF the load switches one by one and simultaneously closing the Gate valve (care must be taken to avoid sudden increase in speed / Volts while switching ‘off ’ the load switches) & stop the pump.
11. Tabulate all the recorded readings and calculate the input power, output power & efficiency of the Turbine.

Calculations:

1. Head on turbine H :
   H = 10 x P where P is the pressure gauge reading in Kg/cm^2

   Flow rate of water $Q = \frac{C_d \; X \; a_1 \; X \; a_2}{\sqrt{a_1^2 - a_2^2}} \; X \; \sqrt{2gh}$ m^3/s

   Where $g = 9.81 \; m/s^2$
   $C_d = 0.62$
   $a_1 =$
   $a_2 =$
   $h = (l_2 - l_1) x \; 12.6$ m.

2. Input power (Hydraulic power input to Turbine)

   IP = WQH/1000 Kw where W = 9810 N/m^3

3. Output power
   $OP = \frac{V \; X \; I}{1000 \; X \; \eta \; gen}$ Kw Where $\eta_{gen} = 0.7$

4. Turbine efficiency $\eta_{turb} = \frac{OP}{IP}$ X 100

5. Unit speed, $N_u = \frac{N}{\sqrt{H}}$

6. Unit discharge, $Q_u = \frac{Q}{\sqrt{H}}$

7. Unit power, $P_u = \frac{OP}{H^{\frac{3}{2}}}$

8. Specific speed, $N_s = \frac{N\sqrt{OP}}{H^5}$

Graphs to be plotted 4

1. **Main Characteristics Curves (constant Head)**

   1. Q_u Vs N_u
   2. P_u Vs N_u
   3. η_o Vs N_u
2. **Operating Characteristics Curves (Constant Speed)**
   4. η_o Vs % full load.

Procedure: Constant Head

1. Install the equipment near a 3 phase 440 volts, 50 Hz, 20 amps power source & water source.
2. Connect the panel to the electrical source & ascertain the direction of the pump is in order (clockwise direction from shaft end) by momentarily starting the pump.
3. Fill filtered clear water into the sump tank up to ¾th its full capacity.
4. Keep the gate valve situated above the pump in fully closed position, turbine guide vanes in full open position.
5. Start the pump, gradually open the gate valve slowly so that the turbine achieves sufficient speed to generate around 200 volts on the panel voltmeter.
6. Wait till the head of the turbine maintained constant.
7. Put on the first electrical load switch and adjust the head of Turbine to 4 kg/cm^2 (can be set to any range from 4 to 4.6 kg/cm^2)on the pressure gauge and record the corresponding Ammeter, voltmeter, rpm indicator & Head over the orificemeter readings.
8. Continue increasing the load on the Turbine step by step by switching ON the consecutive load switches one by one, by gradually opening the Gate valve so that the head of the turbine shows 4 kg/cm^2 on each step. Record the corresponding readings of Ammeter, Pressure Gauge & Head over the notch.
9. Change the Turbine guide vane to any desired position (between fully open to closed conditions) by operating the hand wheel situated at the rear end of the Turbine to repeat the experiment on varied condition by following steps 7 & 8.
10. After the experiment is over bring the turbine to no load condition by switching OFF the load switches one by one and simultaneously closing the Gate valve (care must be taken to avoid sudden increase in speed / Volts while switching 'off ' the load switches) & stop the pump.
11. Tabulate all the recorded readings and calculate the input power, output power & efficiency of the Turbine

Result: Efficiency of Kaplan Turbine =

TABULAR COLUMN:

Speed N (rpm)	Delivery pressure p (kgf/cm^2)	Suction pressure P_v mm of Hg	Time taken for 10 Impulse of energy meter (t_e) s	Water level rise in tank R		Discharge time t (s)
				mm	m	

Speed of pump N (rpm)	Head H m of water	Discharge Q (m^3/s)	Power input to pump P_{in} (kW)	Power developed by pump P_p (kW)	Overall efficiency η_o (%)

Expt. No. 13 **Date: _________**

DETERMINATION OF EFFICIENCY OF CENTRIFUGAL PUMP

Aim: To conduct performance test on a Single stage Centrifugal pump test rig

Theory: A pump may be defined as mechanical device when interposed in a pipe line, converts the mechanical energy supplied to it from an external source into hydraulic energy, thus resulting in the flow of liquid from lower potential to higher potential.The pumps are of major concern to most engineers and technicians. The types of pumps vary in principle and design. The selection of the pump for any particular application is to be done by understanding their characteristics. The most commonly used pumps for domestic, agricultural and industrial are Centrifugal, axial flow, reciprocating, air jet, and diaphram and turbine pumps. Most of these pumps fall into the main class namely Rotodynamic, Reciprocating (positive displacement) and Fluid operated pumps.
The principle of operation of a single stage centrifugal pump is covered under Rotodynamic pump category. In this pump, the liquid is made to rotate in a closed volute chamber. Thus creating the centrifugal action, which gradually builds the pressure gradient towards outlet resulting in a continuous flow.

DESCRIPTION:
The single stage Centrifugal pump test rig mainly consists of:

a) Single stage Centrifugal pump

b) AC Drive motor of suitable capacity coupled to pump by stepped pulley arrangement.

c) SS sump tank and measuring tank with a piezometer

d) G. I. Pipe connections with necessary control valve etc… mounted on a neatly painted M.S. structure. The panel board is equipped with an energy meter for measurement of power input to the motor, a digital RPM indicator to indicate the speed of the pump/motor, a Vacuum gauge to measure suction head, & pressure gauge for measurement of delivery head, a starter of suitable capacity, indicating lamps and fuse etc.

Procedure:

1. Install the equipment near a 3 phase, 440V, 50 Hz, power source and a 25mm tap size watersource.
2. Connect the main power input cable to the power source keeping the switch in ‘off’ position.
3. Fill clear soft water into the sump tank approx. to its full capacity (little less than its full capacity)
4. Keep the outlet control valve (Gate valve) and Butterfly valve situated at the bottom of the measuring tank fully open and prime the pump if necessory.
5. Start the pump by pushing “Green” botton on the starter, the ‘Red’ reset botton Glows, bring the speed control knob to “Zero” position by turning it in anticlock wise direction

CALCULATIONS:

1. **Power input to motor (kW)**

Data: Energy meter constant E.M.C. = 3200 Imp/kw-h

$$IP = \frac{K}{EMC} X \frac{60 X 60}{t} X \eta mot \text{ kW}$$

Where η $_{motor}$ = 0.70, (70 %)

'K' is the number of impulses of energy meter disc = 10 imp

't' is the time taken in seconds by the Energy Meter for 10 imp

2. **Output Power (delivered by the pump) kW**

$$OP = \frac{WQH}{1000} \text{ kW}$$

Where W = 9810 N/m^3

3. **Turbine efficiency** $\eta_{turb} = \frac{OP}{IP}$ X 100

6. Push the ‘Reset’ knob once and turn the speed control knob in clockwise direction very slowly so that the speed of the pump attains 2000 RPM.
7. Water starts flowing into the measuring tank and drains into sump tank.
8. Observe the readings indicated on Vacuum gauge, pressure gauge, energy meter reading by counting 5pulse against time with a stop watch (Time taken in seconds for 10 pulse) and record the same.
9. Close fully the butterfly valve situated at the bottom of the measuring tank and observe the rise in water level in the piezometer record the time taken for 10cm rise in water level on piezometer with the help of a stop watch. Open the butterfly valve to drain the water back to sump tank.
10. Vary the flow rate by operating the outlet control valve in clock wise direction to any desired position (in steps) and follow steps 10 & 11.
11. The experiment can also be conducted at different speeds by varying the speed control knob below 2900 RPM
12. After the experiment is over bring the speed control knob to ‘Zero’ position and stop the pump by pushing ‘Red’ button on the starter.
13. Tabulate all the readings and calculate Input power to the pump, outlet power of pump, discharge, efficiency at each step:

Result: Efficiency of Centrifugal pump =

TABULAR COLUMN:

Type	Difference in mercury level			Rise of water in m	Time taken in sec	Discharge Q m^3/s	Velocity V m/s	Loss of head in m	Coefficient of friction
	h_1	h_2	$H = h_1 - h_2$ in m						

OBSERVATIONS AND CALCULATION:

Co efficient of friction $f = \frac{h_f\, 2gd}{4LV^2}$

Where h_f is loss of head

$h_f = H\left[\frac{S_{Hg}}{S_w} - 1\right]$ m of water

H = Manometer reading in m of Hg

Expt. No. 14 **Date: __________**

FRICTION IN PIPES

Aim: To determine the Co-efficient of friction in flow through pipes of various sizes.

Theory: When a fluid is flowing through a pipe, the fluid experiences some resistance due to which some of the energy of fluid is lost. The loss of energy is classified into

1. Major energy loss: this is due to friction and it is calculated by the following formulae:

   a. Darcy-Weisbach Formula $h_f = \frac{4fLV^2}{2gd}$

   Where h_f = loss of head due to friction

   f = co-efficient of friction which is a function of

   $= \frac{16}{R_e}$ for $R_e < 2000$

   $= \frac{0.079}{{R_e}^{1/4}}$ for $R_e > 2000$

   L = length of pipe

   V = mean velocity of flow

   d = diameter of pipe.

   b. Chezy' s formula $V = C\sqrt{m\,i}$

   Where C = Chezy's constant

   m for pipe is always equal to $\frac{d}{4}$

   i = loss of head due to friction/unit length of pipe.

Procedure:

1. Switch on the pump and open the delivery valve.
2. Open the corresponding ball valve of pipe under consideration.
3. Keep the ball valve of other pipeline closed.
4. Note down the differential head readings in the manometer. (Expel if any air is present by opening the drain cocks provided to the manometer).
5. Close the butterfly valve and note down the time taken for known water level rise.
6. Change the flow rate and take the corresponding reading
7. Repeat the experiment for different diameter of pipelines

Results:

1. Co-efficient of friction in ______dia Pipe = ____________
2. Co-efficient of friction in ______dia Pipe = ____________
3. Co-efficient of friction in ______dia Pipe = ____________

TABULAR COLUMN:

Type	Difference in mercury level			Rise of water in m	Time taken in sec	Discharge Q m^3/s	Velocity V m/s	Loss of head in m
	h_1	h_2	$H = h_1 - h_2$ in m					

OBSERVATIONS AND CALCULATIONS:

1. Loss of energy due to sudden enlargement

$$h = \frac{(V_1 - V_2)^2}{2g}$$

2. Loss of energy due to sudden contraction

$$h = 0.375\frac{V^2}{2g}$$

3. Loss of energy at 90˚ elbow

$$h = 0.75\frac{V^2}{2g}$$

4. Loss of energy at 90˚ bend

$$h = 0.45\frac{V^2}{2g}$$

Expt. No. 15 **Date: __________**

MINOR LOSSES IN PIPES

Aim: To determine various minor losses of energy in flow through pipes.

Theory: When a fluid flows through a pipe, certain resistance is offered to the flowing fluid, which results in causing a loss of energy. The various energy losses in pipes may be classified as:

(i) Major losses.

(ii) Minor losses.

The minor losses of energy are those, which are caused on account of the change in the velocity of flowing fluid (either in magnitude or direction). In case of long pipes these losses are usually quite small as compared with the loss of energy due to friction and hence these are termed 'minor losses' which my even be neglected without serious error. However, in short pipes these losses may sometimes outweigh the friction loss. Some of the losses of energy that may be caused due to the change of velocity are indicated below

Procedure:

1. Switch on the pump and open the delivery valve.
2. Open the corresponding ball valve of pipe under consideration.
3. Keep the ball valves of other pipelines closed.
4. Note down the differential head readings in the manometer.(expel if any air is present by opening the drain cocks provided to the manometer).
5. Close the butterfly valve and note down the time taken for known water level rise.
6. Change the flow rate and take the corresponding reading

Result:

Specification:

Supply pump capacity: 7.5 Kw (10 Hp) 3ph, 400V

Turbine capacity: 2.6 HP (2 Kw)

Run away speed: 2000 RPM

TABULAR COLUMN

Constant Speed:

Sl No	Pressure Gauge reading 'P' Kg/cm	Head over the turbine 'H' in m	Presser Gauge reading in Kg/cm2 Across Venturimeter		Δ h	Alternator		Flow rate 'Q' m3/s	Input power Kw (Ip)	Out put power Kw (Op)	Turbine efficiency % η_{turb}
			h_1	h_1		V volts	I amps				

Graphs to be plotted:

Operating Characteristics Curves (Constant Speed)

4. η_o Vs % full load

Expt. No. 15 **Date: _________**

DETERMINATION OF EFFICIENCY OF FRANCIS TURBINE

Aim: To conduct performance test on a Frrancis turbine

Theory: Hydraulic (water) Turbines are the machines, which use the energy of water (Hydro − power) and convert it into Mechanical energy, which is further converted into electrical energy. Thus the turbine becomes the prime mover to run the electrical generators to produce electricity (Hydroelectric power).

The Turbines are classified as impulse & reaction types. In impulse turbine, the head of water is completely converted into a jet, which exerts the force on the turbine; it is the pressure of the flowing water, which rotates the Impeller of the turbine. Of many types of turbine, the Pelton wheel, most commonly used, falls into the category of impulse turbine, while the Francis & Kaplan falls into the category of reaction turbines.

Normally, Pelton wheel (impulse turbine) requires high heads and low discharge, while the Francis & Kaplan (reaction turbines) require relatively low heads and high discharge. These corresponding heads and discharges are difficult to create in laboratory because of the limitation of required head & discharges. Nevertheless, an attempt has been made to study the performance characteristics within the limited facility available in the laboratories. Further, understanding various elements associated with any particular turbine is possible with this kind of facility.

Francis turbine consists of main components such as Impeller scroll casing and draft tube. Between the scroll casing and the Impeller there are guide vanes, which guides the water on to the impeller thus rotating the Impeller shaft. There are eight guide vanes, which can be turned about their own axis so that the angle of inclination may be adjusted while the turbine is in motion. When guide vane angles are varied, high efficiency can be obtained over wide range of operating conditions.The actual experiment facility supplied consists of a sump tank, centrifugal pump set, turbine unit and Venturimeter arranged in such a way that the whole unit works on recirculating water system.The centrifugal pump set supplies the water from the sump tank to the turbine through control valve (Gate valve). The water from the pump passes through a Venturimeter (for measurement of discharge) to the turbine unit enters the sump tank through the draft tube.

Constant Head:

Sl No	Pressure Gauge reading 'P' Kg/cm	Head over the turbine 'H' in m	Presser Gauge reading in Kg/cm2 Across Venturimeter		Δ h	Alternator		Flow rate 'Q' m3/s	Input power Kw (Ip)	Out put power Kw (Op)	Turbine efficiency % η_{turb}
			h_1	h_1		V volts	I amps				

Main Characteristics Curves (constant Head)

1. Q_u Vs N_u

2. P_u Vs N_u

3. η_o Vs N_u

Procedure: Constant Speed

1. Install the equipment near a 3 phase 440 volts, 50 Hz, 20 amps power source & water source.
2. Connect the panel to the electrical source & ascertain the direction of the pump is in order (clock wise direction from shaft end) by momentarily starting the pump.
3. Fill filtered clear water into the sump tank up to ¾th its full capacity.
4. Keep the gate valve situated above the pump in fully closed position, turbine guide vanes in full open position.
5. Start the pump, gradually open the gate valve slowly so that the turbine achieves sufficient speed to generate around 200 volts on the panel voltmeter.
6. Wait till the speed of the turbine maintained constant.
7. Put on the first electrical load switch and adjust the speed of Turbine to 1600 rpm(can be set to any speed from 1500 to 2000 rpm) on the digital indicator and record the corresponding Ammeter, voltmeter, Pressure gauge & Head over the notch readings.
8. Continue increasing the load on the Turbine step by step by switching ON the consecutive load switches one by one, by gradually opening the Gate valve so that the rpm indicator reading shows 1600 rpm on each step. Record the corresponding readings of Ammeter, Pressure Gauge & Head over the venturimeter.
9. Change the Turbine guide vane to any desired position (between fully open to closed conditions) by operating the hand wheel situated at the rear end of the Turbine to repeat the experiment on varied condition by following steps 7 & 8.
10. After the experiment is over bring the turbine to no load condition by switching OFF the load switches one by one and simultaneously closing the Gate valve (care must be taken to avoid sudden increase in speed / Volts while switching 'off ' the load switches) & stop the pump.
11. Tabulate all the recorded readings and calculate the input power, output power & efficiency of the Turbine.

Note: Drain all the water from the sump tank, refill with fresh clean water once in a month. When the equipment is not in use for a longer duration, drain all water from the sump tank keep it clean & dry.

CALCULATION

Out put power Op = $\frac{V\,X\,I}{1000\,X\,\eta gen}$ η Gen = 0.75

Input power Ip = $\frac{WQH}{1000}$ where W = 9810N/m^2

Q = C_d k √(2ghw) C_d=0.94

K = $\frac{a1\,a2}{\sqrt{a1^{2-}\,a2^{2}}}$

Turbine efficiency $\eta = \frac{OP}{IP}$ X 100 %

Unit speed, $N_u = \frac{N}{\sqrt{H}}$

Unit discharge $Q_u = \frac{Q}{\sqrt{H}}$

Unit power, $P_u = \frac{P\,Shaft}{H^{\frac{3}{2}}}$

Specific speed, $N_s = \frac{N\sqrt{P\,shaft}}{H^{\frac{5}{4}}}$

Procedure: Constant Head

1. Install the equipment near a 3 phase 440 volts, 50 Hz, 20 amps power source & water source.
2. Connect the panel to the electrical source & ascertain the direction of the pump is in order (clock wise direction from shaft end) by momentarily starting the pump.
3. Fill filtered clear water into the sump tank up to ¾th its full capacity.
4. Keep the gate valve situated above the pump in fully closed position, turbine guide vanes in full open position.
5. Start the pump, gradually open the gate valve slowly so that the turbine achieves sufficient speed to generate around 200 volts on the panel voltmeter.
6. Wait till the head of the turbine maintained constant.
7. Put on the first electrical load switch and adjust the head of Turbine to 4 kg/cm2 (can be set to any range from 4 to 4.6 kg/cm2)on the pressure gauge and record the corresponding Ammeter, voltmeter, rpm indicator & Head over the venturimeter readings.
8. Continue increasing the load on the Turbine step by step by switching ON the consecutive load switches one by one, by gradually opening the Gate valve so that the head of the turbine shows 4 kg/cm2 on each step. Record the corresponding readings of Ammeter, Pressure Gauge & Head over the notch.
9. Change the Turbine guide vane to any desired position (between fully open to closed conditions) by operating the hand wheel situated at the rear end of the Turbine to repeat the experiment on varied condition by following steps 7 & 8.
10. After the experiment is over bring the turbine to no load condition by switching OFF the load switches one by one and simultaneously closing the Gate valve (care must be taken to avoid sudden increase in speed / Volts while switching 'off ' the load switches) & stop the pump.
11. Tabulate all the recorded readings and calculate the input power, output power & efficiency of the Turbine.

VIVA-VOCE QUESTIONS

1. What is discharge?
2. What is continuity equation?
3. Write Bernoulli's equation?
4. Derive Darcy's equation?
5. Draw and explain pipe friction apparatus with neat sketch
6. Write a formula for minor loses and major loses of pipe?
7. Write a formula for pressure head H?
8. What is area of wetted perimeter?
9. Write Bernoulli's equation?
10. What are assumptions of Bernoulli's equation?
11. Write Euler's equation?
12. Reynolds number importance?
13. Describe the Reynolds number experiments to demonstrate the two type of flow?
14. Define laminar flow, transition flow and turbulent flow?
15. Define the terms impact of jet and jet propulsion?
16. Find the expression for efficiency of a series of moving curved vane when a jet of water strikes the vanes at one of its tips?
17. What is a pump?
18. What is a centrifugal pump?
19. What are forces involved in impeller?
20. What is priming
21. Classify turbines.
22. Pelton wheel is which type of turbine.
23. What is input energy given to turbine?
24. What are main components of Pelton turbine?
25. Draw velocity diagrams (at inlet and outlet) for Pelton blade
26. Why is Pelton turbine suitable for high heads?
27. What is a reaction turbine?
28. What is difference between impulse and reaction turbine?
29. Specify the flow of the Francis turbine.
30. What head Francis turbine used?
31. What is purpose of draft tube in reaction turbine?
32. What is cavitations?
33. Sketch and explain flow through notch apparatus?
34. What is the application of flow through notch?
35. Define Orifice?
36. Define vena contracta?
37. Define co efficient of velocity?