FLUID DYNAMICS LABORATORY

III Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAEC04	Core	L	T	P	C	CIA	SEE	Total
		0	0	2	1	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 45				Total Classes: 45		
Pre-Requisites: Basic principles of Physics								

I. COURSE OVERVIEW:

The Fluid Dynamics laboratory is designed to explore the properties of fluids and conduct experiments involving both incompressible flow. This course aims to provide fundamental knowledge of basic measurements and devices utilized in fluid dynamic applications. It serves as an introductory course, introducing concepts related to flow behavior, fluid forces, and analytical tools. Additionally, the course covers various flow measurement devices, pumps, turbines commonly employed in fluid dynamic applications, and how to assess their performance characteristics. You will gain hands-on experience investigating the principles of fluid statics, as well as the kinematics and kinetics of fluid flow, along with the operation of turbo machinery.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Gain knowledge on working of centrifugal pumps, positive displacement pumps, hydraulic turbines centrifugalblowers and steam turbines.

II. Compare performance of various machines at different operating points.

III. Knowledge of various flow meters and the concept of fluid mechanics.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1 Infer the concept of calibrating orifice and venturi meter to minimize uncertainty in the discharge coefficient.

CO 2 Utilize the pipe friction test apparatus to measure the friction factor under a range of flow rates and flow regimes for calculating major loses in closed pipes.

CO 3 Demonstrate the validation of Bernoulli's theorem for incompressible, steady, continuous flow in order to regulate pipe flow across a cross-section and datum.

CO 4 Illustrate the critical Reynolds number using Reynolds apparatus for transition of laminar flow into turbulent flow.

CO 5 Make use of the jet impact apparatus to investigate the reaction forces generated due to changes in momentum.

CO 6 Distinguish the performance characteristics of turbo machinery to various operating conditions for calculating efficiency of turbines under specific applications.

EXERCISES FOR FLUID DYNAMICS LABORATORY

Note: Students are encouraged to bring their own laptops for laboratory practice session

1. Getting Started Exercises

1.1 Introduction to Fluid Dynamics Laboratory

1. Understand the working principle of venturimeter, and orifice meter used in the laboratory.
2. Become familiar with the operation and usage of fluid flow through pipes.
3. Learn to take readings of fluid level readings in manometer.

Try

1. Calculate the coefficient of discharge using venturimeter experimental setup
2. Calculate the efficiency of the centrifugal pump, using the experimental setup

2. Exercises on Calibration of Venturimeter

2.1 Venturimeter

Start the pump, operate the valves, measure the variations in manometer readings (h1 & h2), note down the time (t), and calculate the coefficient of discharge using the experimental setup, shown in Figure 1.

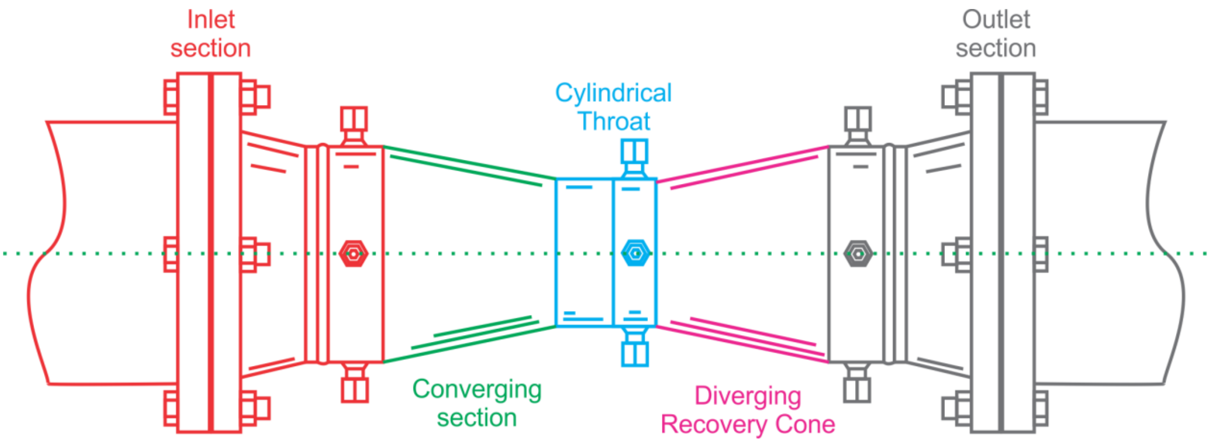

Figure 1. Venturimeter

Try

1. Change the rate of convergence and divergence of venturi and repeat the same experiment.
2. Open the valves half only and repeat the experiment and compare the results with full open condition.
3. Open the valves to 2/3 and repeat the experiment and compare the results with full open condition.

3. Exercises on Calibration of Orifice Meter

3.1 Orifice Meter

Start the pump, operate the valves, measure the variations in manometer readings (h1 &h2), note down the time (t), and calculate the coefficient of discharge the experimental setup, shown in Figures 1 & 2.

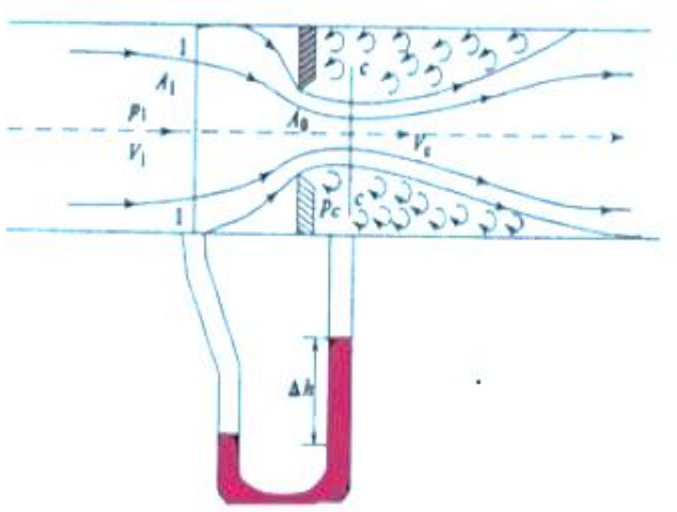

Figure 2. Orifice meter

Try

1. Change the height of wedge for orifice and find the discharge coefficient.
2. Open the valves half only and repeat the experiment and compare the results with full open condition.
3. Change the height of the wedge for orifice, and find the discharge coefficient.

4. Exercises on Pipe Flow Losses in Rectangular Pipe

4.1 Pipe Flow

Start the pump, operate the valves, measure the variations in manometer readings (h1 &h2), note down the time (t), and calculate the discharge, velocity and friction factor using the formula for given circular and rectangular pipes the experimental setup, shown in figure 3.

Try

1. Change the roughness of a pipe and find the friction loses for a square pipe with full valves open
2. Change the dimensions of a pipe, open the valves half only and repeat the experiment for a square pipe and compare the results with full open condition

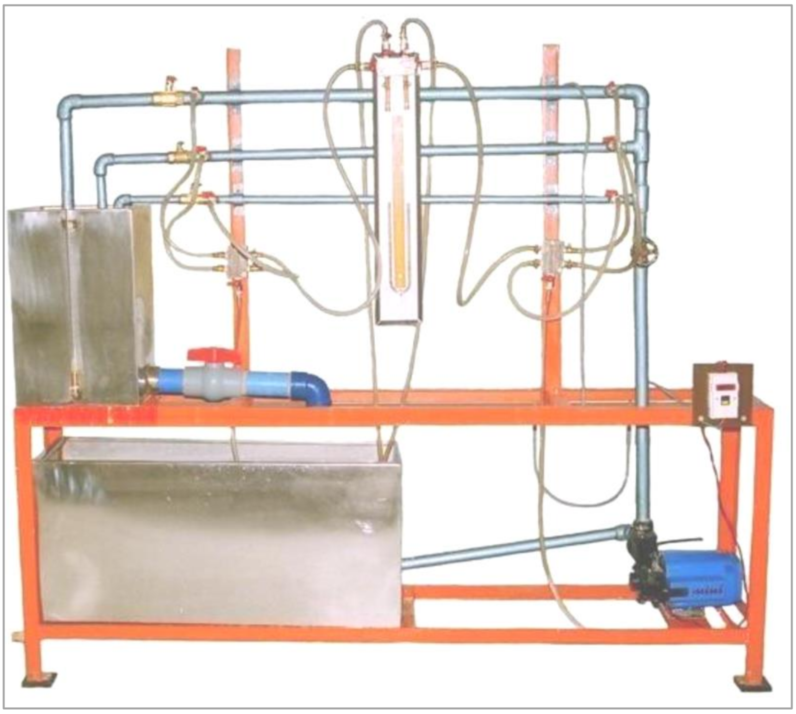

Figure 3. Flow through pipe experiment setup

5. Exercises on Pipe Flow Losses in Circular Pipe

5.1 Pipe Flow

Start the pump, operate the valves, measure the variations in manometer readings (h1 &h2), note down the time (t), and calculate the discharge, velocity and friction factor using the formula for given circular and rectangular pipes the experimental setup, shown in figure 3.

Try

1. Change the roughness of a pipe and find the friction loses for a circular pipe with full valves open.
2. Change the dimensions of a pipe, open the valves half only and repeat the experiment for a circular pipe and compare the results with full open condition.

6. Exercises on Verification of Bernoulli's theorem.

6.1 Bernoulli's theorem

Start the pump, adjust the flow, note down the piezometer readings and time (t), calculate the pressure head, velocity head, and datum head, and verify the Bernoulli's Theorem, using the experimental setup, shown in Figure 4.

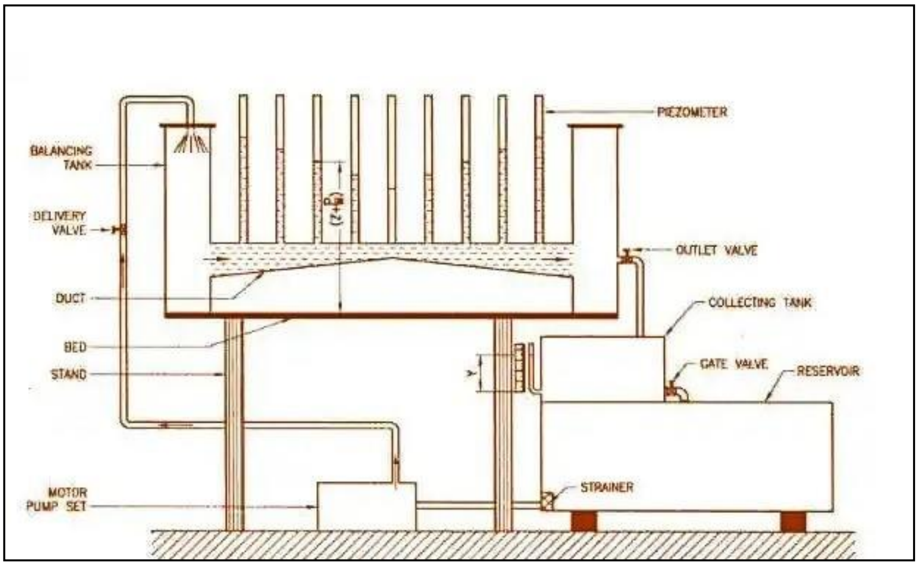
PIEZOMETER
BALANCING TANK
DELIVERY VALVE
OUTLET VALVE
DUCT
COLLECTING TANK
BED
GATE VALVE
RESERVOIR
STAND
STRAINER
MOTOR PUMP SET

Figure 4: Bernoulli experiment setup

Try

1. Vary the mass flow rate and verify Bernoulli's theorem
2. Change the fluid type and verify Bernoulli's theorem

7. Exercises on Impact of Jets on Vanes

7.1 Jets on Vanes

1. Fix the given vane and add dead weight, note down the forces, note down the time, calculate the flow speed, discharge, and coefficient of impact vanes, shown in Figure 5.

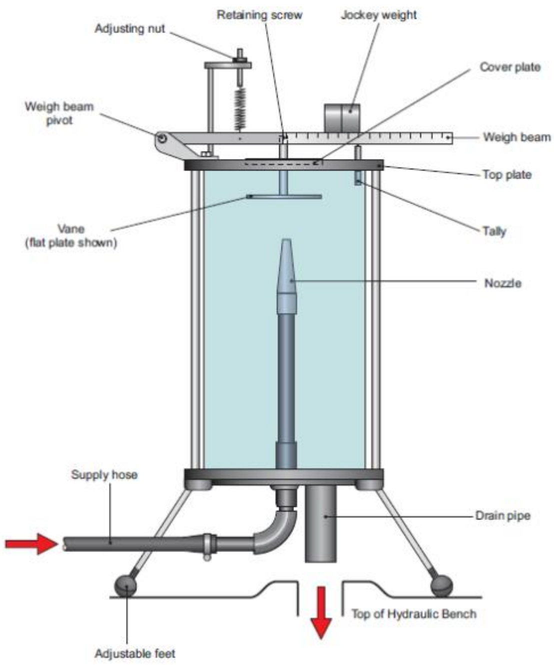

Figure 5: Jet on Vanes

Try

1. Change the vane angle to 45^0 and repeat the same experiment.
2. Change the vane angle to 60^0 and repeat the same experiment.
3. Change the orifice geometry and find the coefficient of impact vanes.

8. Exercises on Performance of Centrifugal Pumps

8.1 Centrifugal Pump

Start the pump, operate the valves, note down the readings for pressure head, time (t), calculate the actual discharge, input power, output power, and calculate the efficiency of the centrifugal pump, using the experimental setup, shown in Figure 6.

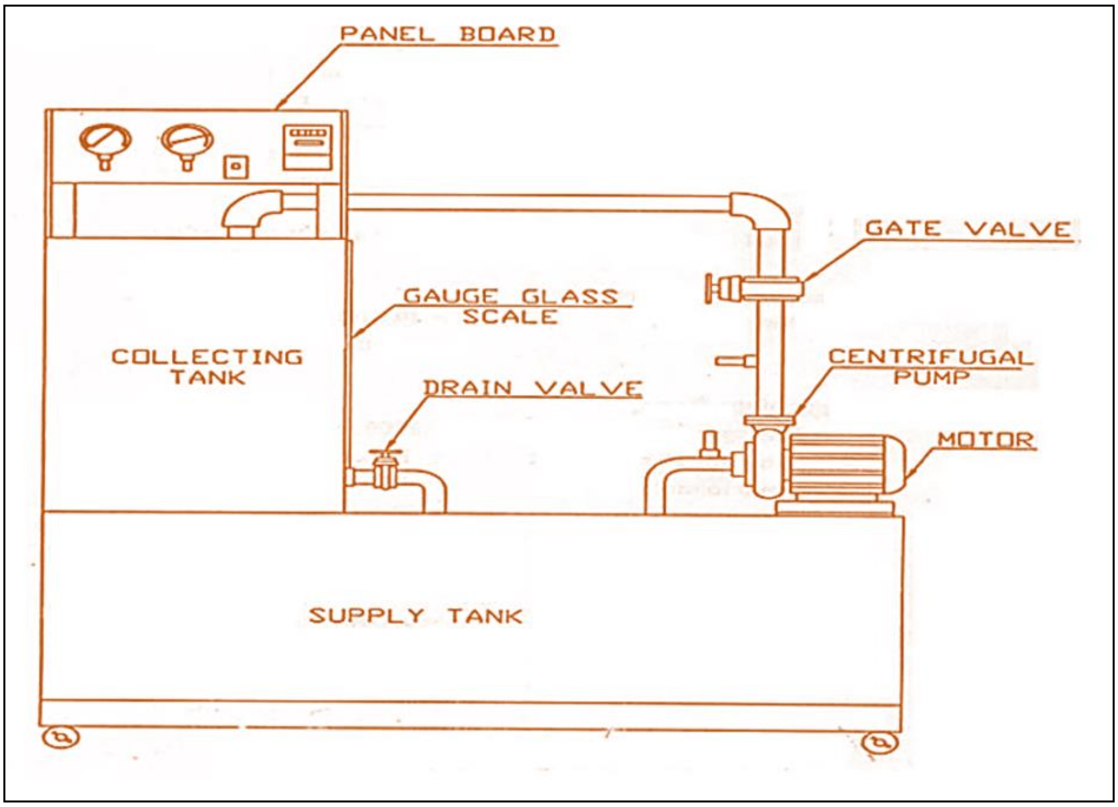

Figure 6: Centrifugal pump experiment setup

Try

1. Note down the time for 15 cm rise of water and calculate the efficiency of the centrifugal pump.
2. Note down the time for 30 cm rise of water and calculate the efficiency of the centrifugal pump.

9. Exercise on Performance of Reciprocating Pump

9.1 Reciprocating Pump

Start the pump, operate the valves, note down the readings for delivery valve, pressure head reading, time (t), calculate the actual discharge, input power, output power, and calculate the efficiency of the centrifugal pump, using the experimental setup, shown in Figure 7.

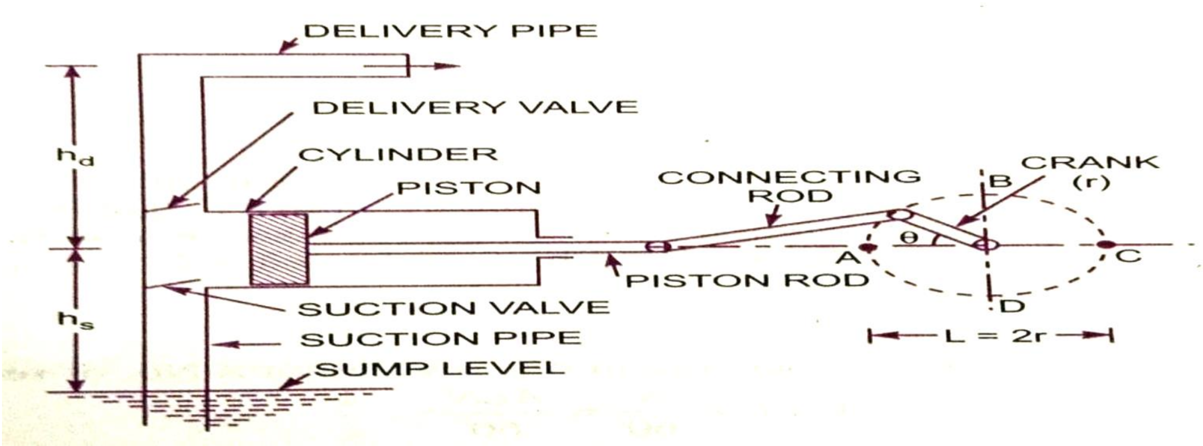

Figure 7: Reciprocating pump setup

Try

1. Note down the time for 15 cm rise of water and calculate the efficiency of the centrifugal pump
2. Note down the time for 30 cm rise of water and calculate the efficiency of the centrifugal pump

10. Exercise on Pelton Wheel Turbine

1. Start the pump, adjust the nozzle opening about half, note down the pressure gauge, vacuum gauge readings, speed of the turbine, manometer readings (h1 & h2), and calculate output power, input power, and efficiency of the Pelton wheel turbine, using the experimental setup, shown in Figure 8.

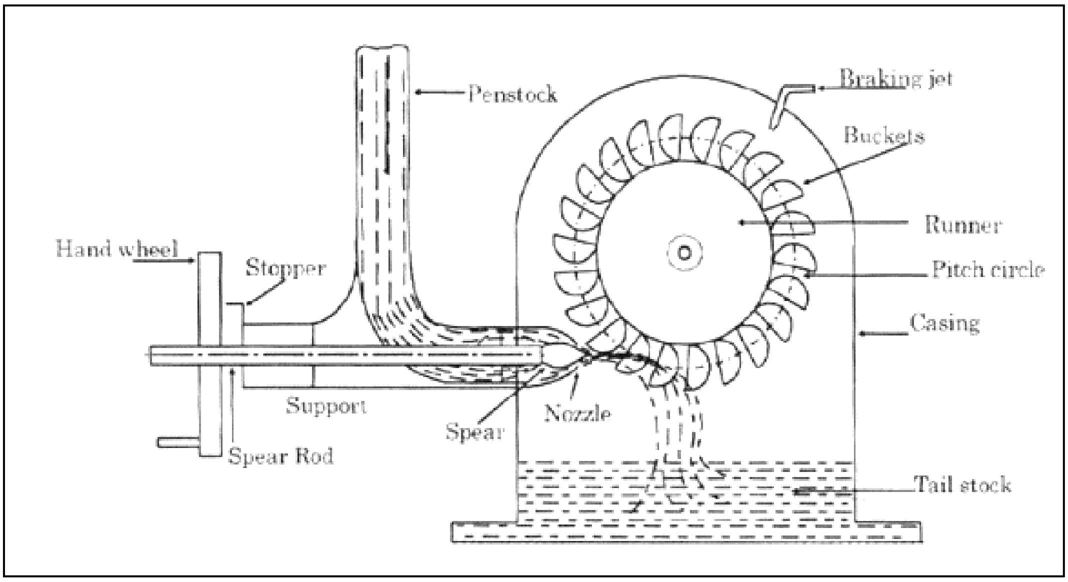

Figure 8: Schematic diagram of a Pelton turbine

Try

1. Adjust the nozzle opening for full, and calculate the efficiency of the Pelton wheel turbine
2. Note down the time for 30 cm rise of water and calculate the efficiency of the centrifugal pump
3. Performance characteristics of Pelton wheel turbine for change in the bucket design
4. Performance characteristics of Pelton wheel turbine for change in datum head

11. Exercise on Francis Turbine

Start the pump, adjust the nozzle opening about half, note down the pressure gauge, vacuum gauge readings, speed of the turbine, manometer readings (h1 & h2), and calculate output power, input power, and efficiency of the Francis Turbine, using the experimental setup, shown in Figure 9.

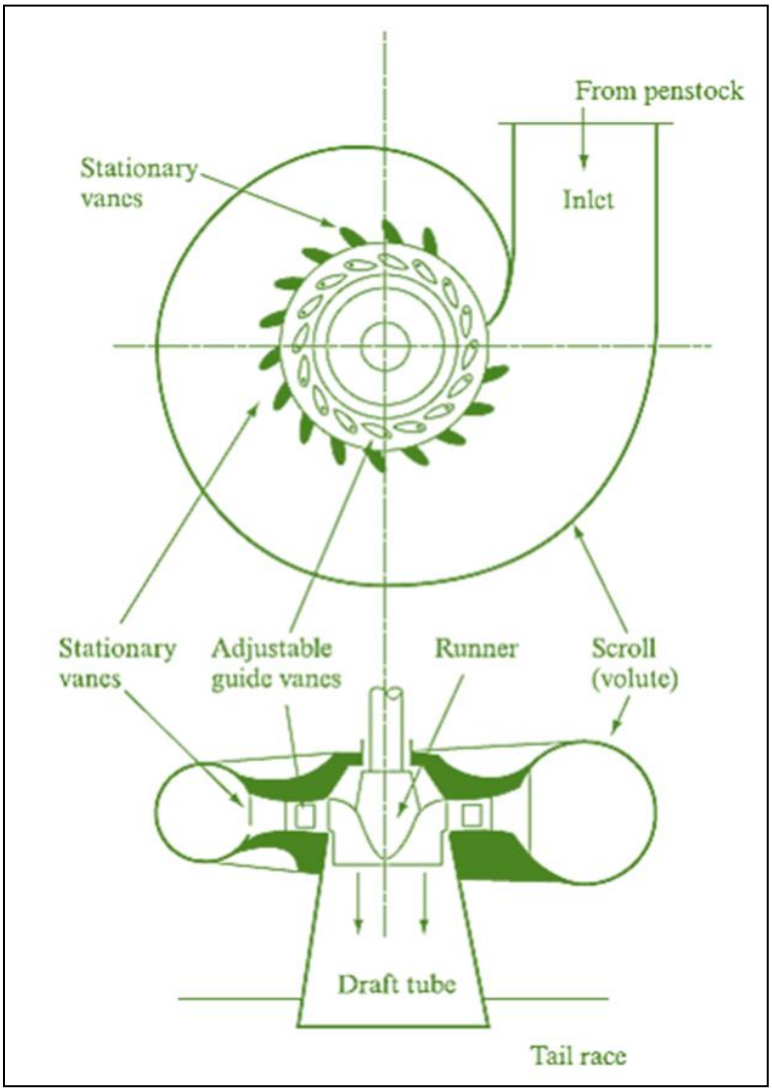

Figure 9: Schematic diagram of a Francis turbine

Try

1. Adjust the nozzle opening for 2/3, and calculate the efficiency of the Pelton wheel turbine
2. Adjust the nozzle opening for full, and calculate the efficiency of the Pelton wheel turbine
3. Performance characteristics of Francis wheel turbine for change in the vane angle
4. Performance characteristics of Francis wheel turbine for change in datum head

12. Exercise on Flow through Notch-I

Fix the plate with V notch in the hydraulic bench, start the pump, note down h1, h2 readings in the notch, calculate actual, theoretical discharge, and find the coefficient of discharge, using the experimental setup, shown in Figure 10.

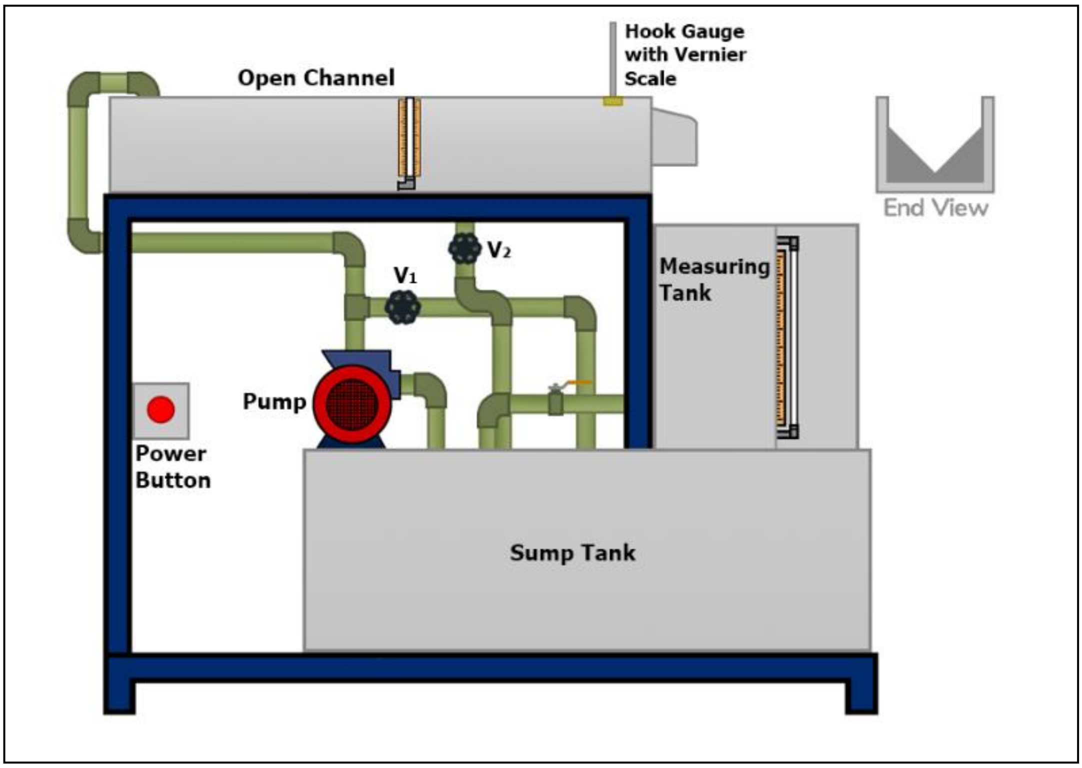

Figure 10: Schematic diagram of a flow through notches experiment.

Try

1. Use trapezoidal weir and find the coefficient of discharge
2. Use sharp-crested weir and find the coefficient of discharge

13. Exercise on Flow through Notch-II

Fix the plate with rectangular notch (figure 11) in the hydraulic bench, start the pump, note down h1, h2 readings in the notch, calculate actual, theoretical discharge, and find the coefficient of discharge, using the experimental setup, shown in Figure 10 &11.

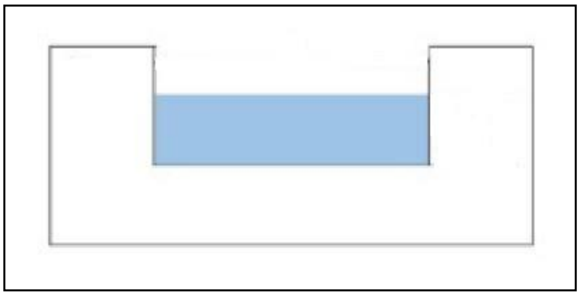

Figure 11: Schematic diagram of a flow through rectangular notch

Try

1. Use Ogee-shaped weir and find the coefficient of discharge
2. Use Broad crested weir and find the coefficient of discharge

14. Exercise on Flow though Orifice Mouth Piece

Fill the sump tank with water, place the given mouth piece, operate the valve, measure the discharge, note down the time (t), and find out the coefficient of discharge

Try

1. Change the height of mouth piece and find the discharge coefficient
2. Change the shape of mouth piece and find the discharge coefficient

V. TEXT BOOKS:

1. Frank M. White, "Fluid Mechanics ", McGraw Hill Education Private Ltd, 9th edition, 2022.
2. R. K Bansal, “Fluid Mechanics and Hydraulic Machines”, Laxmi Publications Ltd, Revised 9th edition, 2019.

VI. REFERENCE BOOKS:

1. Rathakrishnan. E, “Fluid Mechanics, an introduction”, PHI Learning Pvt. Ltd, 2022.

VII. ELECTRONICS RESOURCES:

1. https://archive.nptel.ac.in/courses/112/105/112105171/
2. https://akanksha.iare.ac.in/index?route=course/details&course_id=522

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual