FLUID MECHANICS LAB PORTFOLIO

Course ID: ME - 3408

Department: Mechatronics Department – College of Engineering

Lab Objectives:

1. Understand fundamentals of fluid mechanics and enhances skills of utilizing fluid mechanics for mechatronics engineering applications.
2. Apply Fluid Mechanics principles to calculate fluid parameters at different conditions
3. Observe the components of flow and coefficient of discharge measuring devices and recognize them with their basic concepts.
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Contents:

The course comprises of experiments and demonstrations related to U-Tube Manometer, Centrifugal Pump, Bernoulli's Theorem, Venturi & Orifice Tube, Pitot Tube, Pipe fitting & gate valve losses, Pipe friction losses (Laminar & Turbulent flows), Hydrostatic Pressure, Jet Force through nozzle.

Text Books:

1. Fluid Mechanics, 5th Edition by **F M. White**, Published by McGraw-Hill Education, 2003.
2. Fundamental of Fluid Mechanics, 7th Edition, **B R Munson, D F Young and T H Oliishe, J Wiley**, 2012.

BERNOULLI’s THEOREM

The **Bernoulli’s Theorem** apparatus consists of a classical Venturi made of clear acrylic. A series of wall tapings allow measurement of the static pressure distribution along the converging duct, while a total head tube is provided to traverse along the centre line of the test section. These tapings are connected to a manometer bank incorporating a manifold with air bleed valve. Pressurization of the manometers is facilitated by a hand pump.

This unit has been designed to be used with a Hydraulics Bench for students to study thecharacteristics of flow through both converging and diverging sections. During the experiment, water is fed through a hose connector and students may control the flow rate of the water byadjusting a flow regulator valve at the outlet of the test section.The venturi can be demonstrated as a means of flow measurement and the discharge coefficient can be determined. This test section can be used to demonstrate those circumstances to which Bernoulli’s Theorem may be applied as well as in other circumstances where the theorem is not sufficient to describe the fluid behavior.

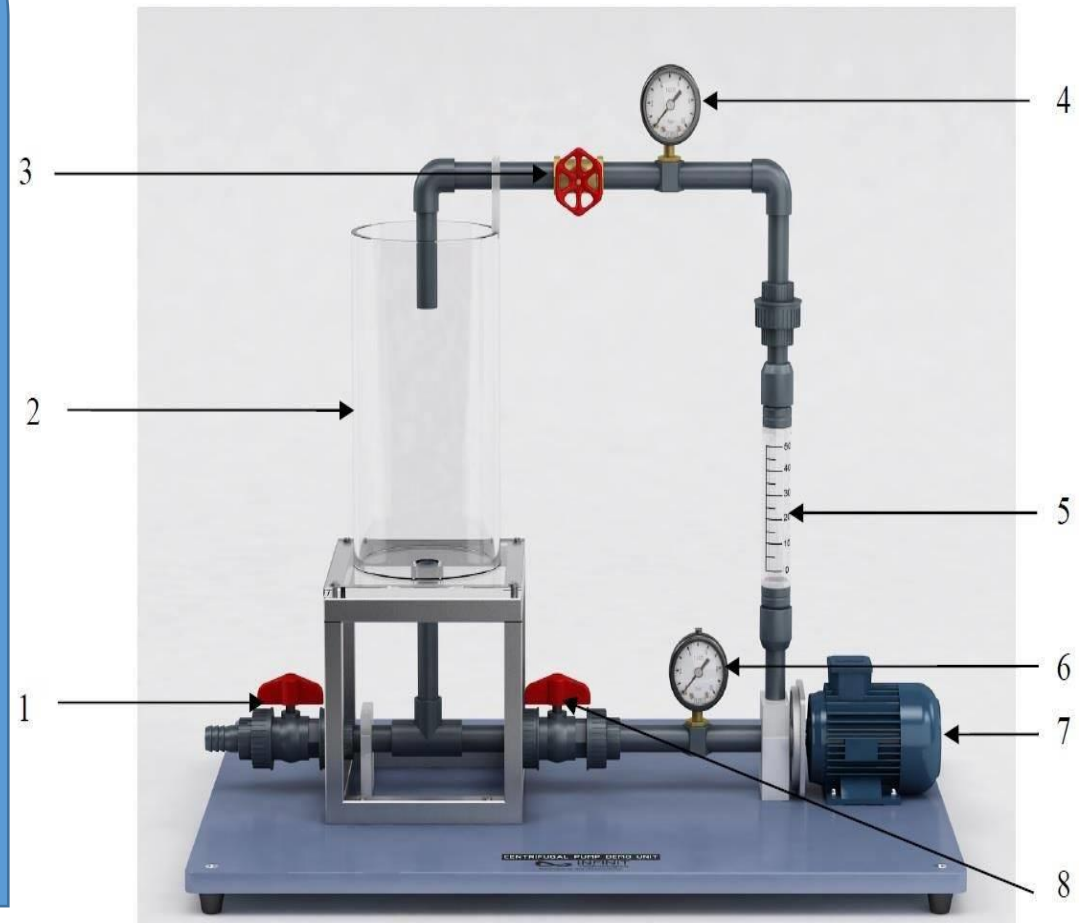
CENTRIFUGAL PUMP

The **Centrifugal Pump Demonstration** consists of a single centrifugal pump which can be used in association with the pump in hydraulics bench to generate a number of pump configurations. A full description of the apparatus is given later in these texts. The apparatus is capable of;

- Recording of characteristic pump curves.
- Determination of pump efficiency.
- Effect of speed on discharge quantity and head.

Demonstration model of a centrifugal pump. Set-up on Stainless Steel HDF base plate. Transparent tank 15Ltr, Measurement of pressure, speed, flow rate. Volumetric flow measurement via measuring variable area flow meter

1. Drain Valve V3
4 Flow control Valve V2
5. Flow meter
7. Centrifugal Pump
2. Acrylic Glass Tank
4. Discharge Pressure Gauge p2
6. Suction Pressure Gauge p1
8. Inlet Valve V1



ENERGY LOSSES BENDS AND FITTINGS

The **Energy losses in bends & pipe fitting** apparatus has been designed for student's experiment on the investigation of energy losses in pipe bends and fittings as well as gate valve. The equipment is mounted on a free-standing framework supporting the test pipe work and instrumentations. These pipe fittings include miter bend, 90° elbow, sweep bend, contraction and enlargement.

Experimental Capabilities:

1. Measuring the losses in the fittings related to flow rate and calculating loss coefficients related to velocity head.
2. Comparing the pressure drop across each fitting.

IMPACT OF JET APPARATUS

INTRODUCTION:

The **Impact of Jet Apparatus** is designed to investigate jet forces impacting against stationary deflectors. The impact forces are produced by a water jet. The impact forces are measured using a mechanism and loading weights.

The impact forces of the water jet are set via the flow rate. Water is supplied from the hydraulic bench.

GENERAL DISCRIPTION:

The unit is designed to investigate jet forces impacting against stationary deflectors. The impact forces are produced by a water jet. The impact forces are measured using a lever mechanism and loading weights.

The impact forces of the water jet are set via the flow rate. Water is supplied either from the Hydraulic Bench basic flow module or by way of the laboratory main supply.

FLOW MEASUREMENT APPARATUS

The **Flow Meter Measurement** Apparatus is designed to operate together with a basic hydraulic bench or any water supply. It is to familiarize the students with typical methods of flow measurement of an incompressible fluid.

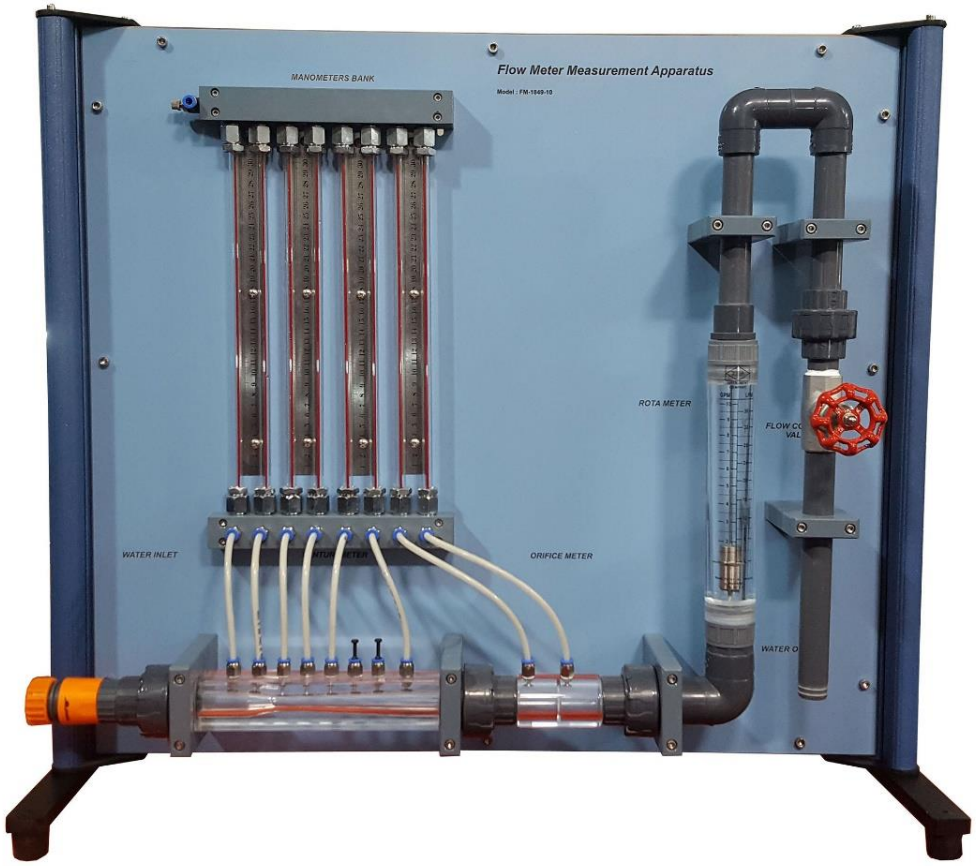
The apparatus is able to demonstrate the flow measurement comparison by using a venture device, orifice device and rotameter. The flow comparison can be further being used to compare against the flow measurement of the hydraulics bench which can be done by Volumetric Method.

Venturi Meter:

The venturi meter consists of a venturi tube and a suitable differential pressure gauge. The venture tube has a converging portion, a throat and a diverging portion

Orifice Meter:

The orifice for use as a metering device in a pipeline consists of a concentric square-edged circular hole in a thin plate, which is clamped between the flanges of the pipe



HYDROSTATIC PRESSURE

The effect of hydrostatic pressure is of major significance in many areas of engineering, such as Ship building, the construction of dykes, weirs and locks, and in sanitary and building services Engineering. With **Hydrostatic Pressure** apparatus the correlation between the water level and the dependent side pressure can be investigated. The unit is of robust construction and can be set up quickly. It is therefore highly suitable for everyday use in schools and universities. A transparent measuring vessel with mm scale and a scale with mm increments permits precise water level and lever arm readings. It is used to calculate forces acting on masonry dams or ships' hulls, for example, from the hydrostatic pressure, two steps are required:
Reduce the pressure load on an active surface down to a resultant force Fp, which is applied at a point of application of force, the "centre of pressure", vertical to the active surface.
Determine the position of this centre of pressure by determining a planar centre of force on
the active surface.

U-TUBE MANOMETER

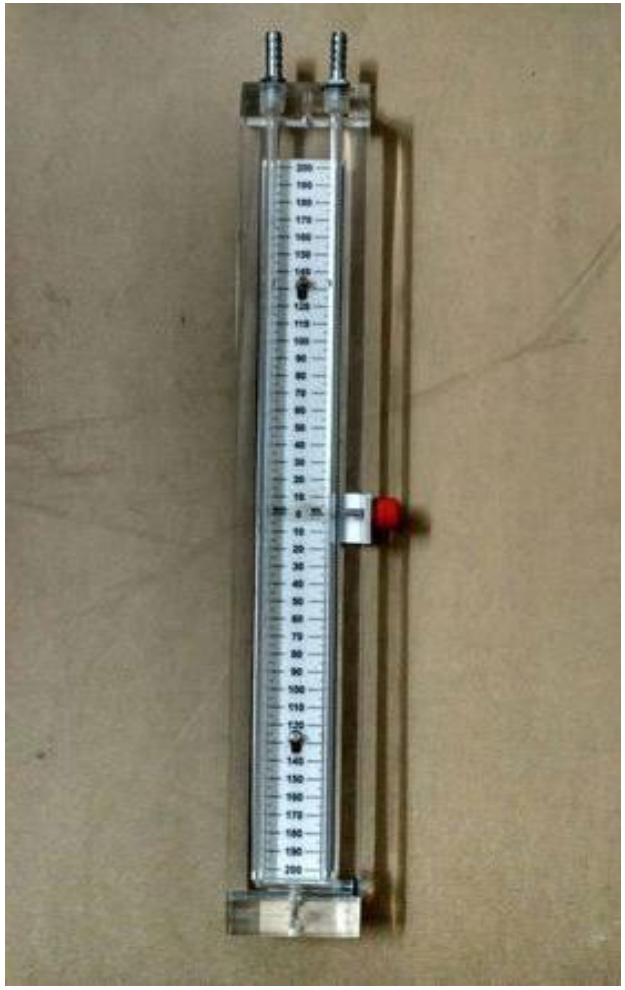
A **U-Tube Manometer Apparatus** is a differential pressure measuring **instrument in which we take a difference in readings for the columns' height in 'mm' for** the rise of applied pressure at one end providing one end at atmospheric pressure.

U-Tube Manometer:

The U-tube manometer is somewhat self-descriptive. In its basic form it consists of a clear glass or plastic tube shaped into the form of a 'U'. The tube is partially filled with a liquid, such as water, alcohol, or mercury (although for safety reasons mercury is no longer commonly used). The lower the density of the liquid, the higher the sensitivity of the manometer.

In a U-tube manometer, the difference between the unknown pressure and atmospheric pressure is the gauge pressure.

We are using it to determine the unknown pressure applied by a source



PITOT TUBE

The **Pitot Tube** is a pressure measurement instrument used to measure fluid flow velocity.
The pitot tube was invented by the French engineer Henri Pitot in the early 18th century and was
modified to its modern form in the mid-19th century by French scientist Darcy. It is widely used to determine the airspeed of an aircraft and to measure air and gas velocities in industrial applications. The Pitot tube is used to measure the local velocity at a given point in the flow stream and not the average velocity in the pipe or conduit.
The **Pitot Tube** apparatus consists of a tube pointing directly into the fluid flow. As this tube contains fluid, a pressure can be measured; the moving fluid is brought to rest (stagnates) as there is no outlet to allow flow to continue. This pressure is the stagnation pressure of the fluid, also known as the total pressure or (particularly in aviation) the pitot pressure.
The measured stagnation pressure cannot of itself be used to determine the fluid velocity
(air speed in aviation).

PIPE FRICTION APPARATUS

The **Pipe Friction Apparatus** is used to examine pipe friction losses in laminar and turbulent
flow. The unit is used to examine pipe friction losses in laminar and turbulent flow. The pipe section used has an inside diameter of 4mm and a length of 500mm.The pressure losses are measured in laminar flow with a water manometer. The static pressure difference is indicated. In turbulent flow the pressure difference is measured with a water filled manometer. A level tan is provided to generate the laminar flow. It ensures a constant water inflow pressure on the pipe section at a constant water level. The level tank is not used to generate turbulent flow. The water is fed directly from the water main into the pipe section. The flow rate is set by means of valves at each end of the pipe.