Hashemite University
Faculty of Engineering
Civil Engineering Department

Fluid and Hydraulic Lab

List of Expiements

1. Hydrostatic Force and Center of Pressure
2. Orifice and Jet Flow.
3. Bernoulli's Theorem and Venturi Meter.
4. Impact of Water Jet.
5. Friction in Pipes and Losses from Fittings and Bends.
6. Specific Energy: Slow and Fast Flow
7. Hydraulic Jump.
8. The Flow beneath a Sluice Gate (An Undershot Weir)
9. The Flow Through Rectangular Sharp Crested Weir
10. Pumps in Parallel and Series.

Fluids & Hydraulics Lab

Device Name: center of pressure.
Used For: To determine the position of the center of pressure on the rectangular face of the partially or entirely submerged object in the water.
Experiment associated with it: center of pressure.
Courses associated with it: Fluid mechanics.

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Machine Identification Card

Name	Manufacturer
Center Of Pressure	TecQuipment-UK
	Model No. H11

Machine Description

- The equipment consists of a vertical panel that holds a clear plastic quadrant, to which students add water. The quadrant has engraved lines to help students keep the plane in a vertical or angled position.
- The cylindrical sides of the quadrant have their central axis coincidental with the moment measurement axis. The total fluid pressures on these curved surfaces therefore exert no moment about this pivot. Therefore, the moment is only due to the fluid pressure on the plane test surface. Students measure this moment using weights suspended from a level arm. A scale on the panel of the apparatus shows the head of water.
- The equipment includes non-toxic water dye to help students see the water levels more clearly and a syringe for accurate addition or removal of small amounts of water.

Safety Instructions

- Never operate this apparatus unless you have been fully trained and have received and understand all operating instructions.

Maintenance Record

No maintenance required

The experiment conducted on this machine

- **Center of pressure on a plane surface.**

The experiment summary

- **Studying the relationship between hydrostatic force and head of water for a fully and partially submerged vertical and inclined plane**
- **Comparison of actual and theoretical hydrostatic force on a fully or partially submerged plane for any given head of water**
- **Theoretical calculation of the position of center of pressure on a fully or partially submerged plane**

CENTER OF PRESSURE PROCEDURE

1. Hook an empty weight hanger to the support and add the colored water to the trim tank to create a balance such that the submerged surface is vertical.

2. Start with 10 grams mass. Place it in the hanger and add water to the quadrant tank until the tank becomes level. Record the water depth (y) versus the mass (m) for the partially submerged surface.

3. Repeat step 2 with 20 grams increments. Record the water depth (y) versus the mass (m) for the partially submerged surface.

4. Continue step 3 for fully submerged surface. Record the water depth (y) versus the mass (m).

Fluids & Hydraulics Lab

Device Name: Orifice and jet flow.
Used For: To study the flow through an orifice and determine the discharge coefficient, velocity coefficient and the actual jet profile.
Experiment associated with it: orifice and jet flow.
Courses associated with it: Fluid mechanics.

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Machine Identification Card

Name	Manufacturer
Orifice and jet flow apparatus	Arm field Limited
	Model No. F1-17

Machine Description

In the Orifice & Free Jet Flow accessory a constant head tank is fed with water from the Hydraulics Bench. The orifice is installed at the base of this tank by means of a special wall fitting, which provides a flush inside surface.

Safety Instructions

1. Never operate this apparatus unless you have been fully trained and have received and understand all operating instructions
2. Injury through misuse.

Maintenance Record

No maintenance required

The experiment conducted on this machine

- Orifice and Jet Flow

The experiment summary

- **To study the flow through an orifice and determine the discharge coefficient, velocity coefficient and the actual jet profile.**

ORIFICE AND JET FLOW PROCEDURE

1. **Fill the tank to a constant water depth (h). Record h.**

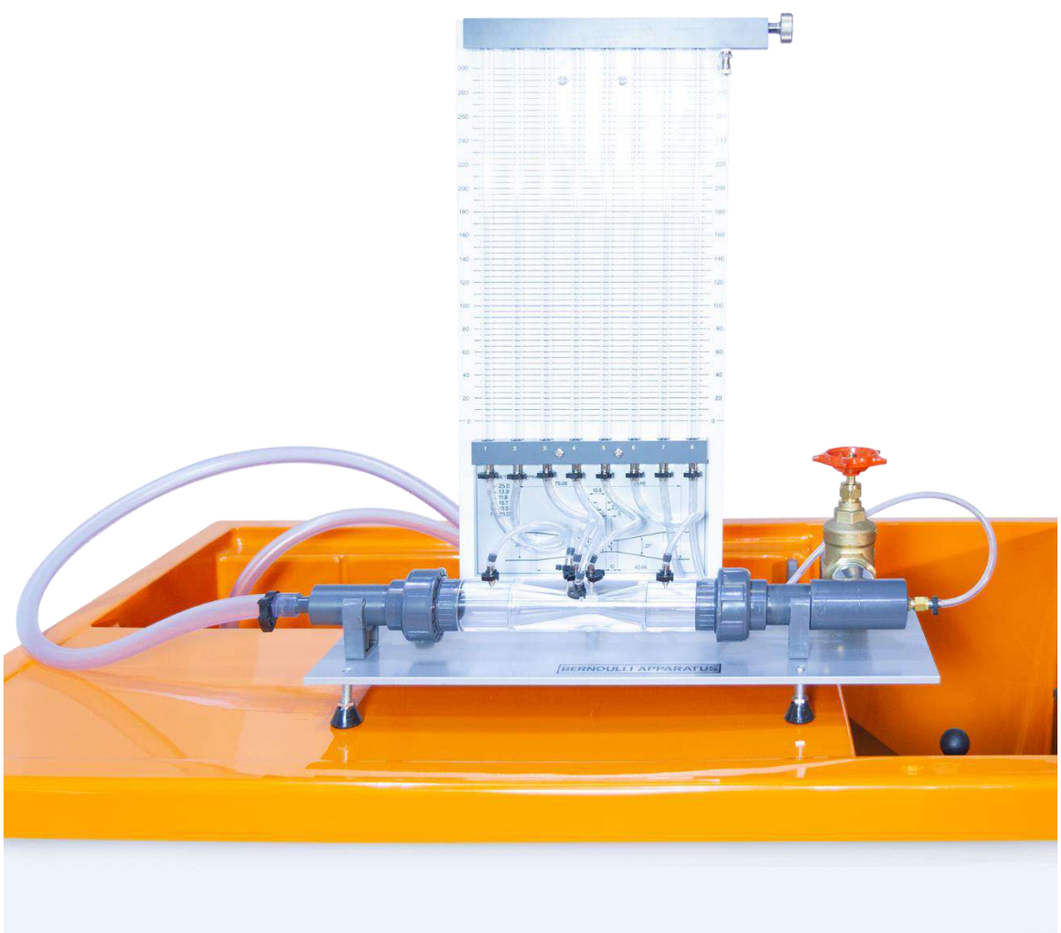
2. **Let water flows through the orifice and observe the jet trajectory as it leaves the orifice. Use needles to measure the jet horizontal and vertical distances (X and Y). Record X and Y.**

3. Measure the water volume collected versus the time recorded. Record V and time.

4. Repeat the steps 1 – 3 at different h values.

Fluids & Hydraulics Lab

Device Name: Bernoulli's Theorem Demonstration
Used For: Demonstrate the relation of pressure head, velocity head and static head and compare it with Bernoulli's Theorem. Study the flow through the Venturi meter as a device of measuring the flow rate. Find the Venturi discharge coefficient. Obtain some of material mechanical properties.
Experiment associated with it: BERNOULI THEOREM
Courses associated with it: Fluid mechanics.



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Machine Identification Card

Name	Manufacturer
Bernoulli's theorem apparatus	Arm field Limited
	Model No. F1-15

Machine Description

The test section consists of a classical Venture machined in clear acrylic. A series of wall tapping's enable measurement of the static pressure distribution along the converging and diverging duct. A total head tube is provided to traverse along the center line of the test section. These tapping's are connected to a manometer bank incorporating a manifold with an air bleed valve.

Safety Instructions

3. Never operate this apparatus unless you have been fully trained and have received and understand all operating instructions

Maintenance Record

No maintenance required

The experiment conducted on this machine

- Bernoulli's Theorem Application - Flow through Venturi Tube.

The experiment summary

- **Demonstrate the relation of pressure head, velocity head and static head and compare it with Bernoulli's Theorem. Study the flow through the Venturi meter as a device of measuring the flow rate. Find the Venturi discharge coefficient. Obtain some of material mechanical properties.**

BERNOULI THEOREM PROCEDURE

1. **Let a stable flow runs through the test tube and wait until the manometers show stable readings.**

2. **Insert the total head probe at different points, observe and record the total head readings on manometer 8.**

3. **Remove the total head probe and read the static head at points 1 and 5.**

4. **Record the collected water volume (V) and time to obtain V.**

5. **Repeat the steps 1 – 4 at different Q values.**

Fluids & Hydraulics Lab

Device Name: impact of water jet.
Used For: To produce and measure force resulted by a water jet when it strikes a target.
Experiment associated with it: impact of water jet.
Courses associated with it: Fluid mechanics.

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Machine Identification Card

Name	Manufacturer
Impact of water jet apparatus	Arm field Limited
	Model No. F1-16

Machine Description

The apparatus consists of a cylindrical clear acrylic fabrication with provision for levelling. Water is fed through a nozzle and discharged vertically to strike a target carried on a stem, which extends through the cover. A weight carrier is mounted on the upper end of the stem.

Safety Instructions

4. Never operate this apparatus unless you have been fully trained and have received and understand all operating instructions

Maintenance Record

No maintenance required

The experiment conducted on this machine

- Impact of water jet

The experiment summary

- **To produce and measure force resulted by a water jet when it strikes a target.**
- **To compare the results with the theoretical values that calculated from the momentum equation.**

Impact of Water Jet

1. **Fit the selected target on the setup and record the deflection angleθ.**

2. **Select an external balancing mass (m). Adjust the flow rate such that the target is balanced.**

3. **Record the mass (m), the collected water volume (V) and time to obtain V.**

4. **Repeat the steps 1 – 3 at different m and Q values.**

Fluids & Hydraulics Lab

Device Name: fluid friction measurement.
Used For: To demonstrate the friction loss in pipes, valves and other fittings. To determine experimentally the relationship between friction factor and Reynolds number for flow of water in a pipe.
Experiment associated with it: Fluid friction.
Courses associated with it: Fluid mechanics.

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Machine Identification Card

Name	Manufacturer
Fluid Friction measurement	Arm field Limited
	Model No. C6-MKII-10

Machine Description

The main components for this test are pump and water storage tank, differential manometer for measuring the head at different point along the pipe and across the fittings, and volumetric measuring tank to measure the flow rate.

Safety Instructions

Never operate this machine unless you have been fully trained and have received and understand all operating instructions

Maintenance Record

No maintenance required

The experiment conducted on this machine

- Fluid friction in pipes and losses from fittings.

The experiment summary

To demonstrate the friction loss in pipes, valves and other fittings. To determine experimentally the relationship between friction factor and Reynolds number for flow of water in a pipe.

Friction in Pipes and Losses from Fittings and Bends Procedure

1. **Let water runs through the pipe selected to test and record the pipe diameter (d). Read and record the static head over both ends of the pipe and record the water volume and time to compute Q and v. Repeat step 1 at different Q and v values.**

2. **Select a bend to test and let water runs. Read and record the static head over both ends of the bend and record the water volume and time to compute Q and v given the pipe diameter. Repeat step 2 at different Q and v values.**

3. **Repeat step 2 for a selected fitting.**

Fluids & Hydraulics Lab

Device Name: hydraulic flow demonstrator.
Used For: demonstration of various flow phenomena.
Experiment associated with it: • Slow and fast flow. • Hydraulic jump. • Flow beneath sluice gate. • Flow through rectangular sharp crested weir.
Courses associated with it: hydraulic.

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Machine Identification Card

Name	Manufacturer
Hydraulic flow demonstrator	Arm field Limited
	Model No. S16

Machine Description

- The flow channel of the S16 Hydraulic Flow Demonstrator is constructed using clear acrylic for visibility and is supported by a floor-standing, metal frame fitted with castors for mobility.
- The flow channel consists of an inlet tank with overflow and flow stilling arrangement, a rectangular working section and a discharge tank.
- Control valves and adjustable weirs allow the flow conditions to be varied independently at the entry to and exit from the working section. The working section can be flooded to create a closed conduit or operate partially filled as an open channel.
- The S16 Hydraulic Flow Demonstrator is designed to be used in conjunction with an Arm field F1-10 Hydraulics Bench, which provides a recirculating water supply and a volumetric measuring facility. The Flow Demonstrator can be used with an independent water supply of up to 1.6 l/s provided that water discharging from the channel can be intercepted.
- An optional direct reading flow meter is available that allows rapid adjustment to the required flow conditions.

Safety Instructions

5. Never operate this machine unless you have been fully trained and have received and understand all operating instructions
6. Never place any part of your body where it can be struck of crushed by part movement.

Maintenance Record

No maintenance required

The experiment conducted on this machine

- Flow Beneath a Sluice gate.
- Flow over sharp crested weir.
- Hydraulic Jump.
- Specific Energy.

The experiment summary

- **To study various flow phenomena.**

Specific Energy: Slow and Fast Flow Procedure

1. **Select a flow rate and let water runs in the channel. Record the flow rate.**

2. **Adjust the sluice gate opening to regulate the flow on both sides of the gate. Record the flow depths (h) upstream and downstream the gate.**

3. Repeat step 2 at different gate openings. Record the flow depths upstream and downstream the gate. The experiment requires at least 6 - 8 depth values upstream and downstream the gate.

Hydraulic Jump Procedure

1. **Select a flow rate and let water runs in the channel. Record the flow rate.**

2. **Use the sluice gate and the channel end gate to regulate the flow and develop the jump.**

3. **Record the flow depth upstream and downstream the jump. Record the jump length.**

4. **Repeat the steps above at different flow rates.**

The Flow beneath a Sluice Gate (An Undershot Weir) Procedure

1. **Open the gate at hg = 15mm. Start with low flow rate such that h0 is always > hg. Let the water runs, measure and record experimental Qa and h0.**

2. **At the same gate opening (hg = 15mm), increase the flow rate and record Qa and h0.**

3. **Repeat the steps above for hg = 25mm**

The Flow through Rectangular Sharp Crested Weir Procedure

1. **Place the sharp weir in the channel and start with low flow rate. Let the water runs, record Qa and H. make sure that the nappe after the weir is ventilated.**

2. Increase the flow rate and record the new Qa and H values. Make sure that the nappe after the weir is ventilated.

Fluids & Hydraulics Lab

Device Name: Series and parallel pump test.
Used For: To study the relation between head and flow rate of two pumps where connected in parallel or series.
Experiment associated with it: Series and parallel pumps.
Courses associated with it: hydraulic.

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Machine Identification Card

Name	Manufacturer
Series/ Parallel Pumps	Thailand
	Model No. ---------

Machine Description

Two identical centrifugal pumps can be configured for single pump operation, two pumps in series, and two pump operations in parallel configuration using manually operated ball valves. These valves also, are used for controlling of water flow rate.

Safety Instructions

7. Never operate this machine unless you have been fully trained and have received and understand all operating instructions
8. Never place any part of your body where it can be struck of crushed by part movement.

Maintenance Record

No maintenance required

The experiment conducted on this machine

- Series/ Parallel Pumps

The experiment summary

- **To study the relation between head and flow rate of two pumps where connected in parallel or series.**

Pumps in Parallel and Series Procedure

1. **For the single pump, make arrangements to use one pump. Start with low flow rate, record the pump suction and delivery heads, the pump rotational speed (N) and torque (T) generated. Repeat this step for other two different flow rates.**

2. **For two pumps in parallel, make arrangements to connect the two pumps in parallel. Start with low flow rate, record the connected pumps suction and delivery heads. Repeat this step for other two different flow rates.**

3. **For two pumps in series, make arrangements to connect the two pumps in series. Start with low flow rate, record the connected pumps suction and delivery heads. Repeat this step for other two different flow rates.**