NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(Accredited by NAAC, Approved by AICTE New Delhi, Affiliated to APJKTU)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF MECHATRONICS

LAB WORK BOOK

ME230- FLUID MECHANICS AND MACHINES LABORATORY

VISION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

MD 1: The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.

MD 2: The department is committed to impart the awareness to meet the current challenges in technology.

MD 3: Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

PEO2: Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

PEO3: Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

PEO4: Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

PROGRAM OUTCOMES (PO'S)

Engineering Graduates will be able to:

PO 1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO 1: Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

PSO 2: Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

COURSE OUTCOME

C216.1	Acquire the basic knowledge and experimentally determination of discharge through the flow measuring equipment – orificemeter, venturimeter
C216.2	Acquire the knowledge about factors affecting the efficiency of a centrifugal pump, reciprocating pump ,gear oil pump
C216.3	Demonstrate the factors related to the efficiency of Pelton wheel, Francis turbine, Kaplan turbine
C216.4	Examine the factors affecting the flow through pipes
C216.5	Acquire the basic knowledge about notches
C216.6	Examine about the major losses in a pipe flow & physical basis of Bernouli's equation

CO VS PO'S AND PSO'S MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PS01	PSO2
C216.1	3	3	3	3	-	-	-	-	**3**	-	-	2	3	3
C216.2	**3**	**3**	3	**3**	-	-	-	-	**3**	-	-	**2**	**3**	**3**
C216.3	**3**	**3**	3	**3**	-	-	-	-	**3**	-	-	**2**	**3**	**3**
C216.4	**3**	**3**	3	**3**	-	-	-	-	**3**	-	-	**2**	**3**	**3**
C216.5	**3**	**3**	3	**3**	-	-	-	-	**3**	-	-	**2**	**3**	**3**
C216.6	3	3	3	3	-	-	-	-	**3**	-	-	2	3	3
C 216	**3.00**	**3.00**	**3.00**	**3.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.00**	**0.00**	**0.00**	**2.00**	**3.00**	**3.00**

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

PREPARATION FOR THE LABORATORY SESSION
GENERAL INSTRUCTIONS TO STUDENTS

1. Read carefully and understand the description of the experiment in the lab manual. You may go to the lab at an earlier date to look at the experimental facility and understand it better. Consult the appropriate references to be completely familiar with the concepts and hardware.

2. Make sure that your observation for previous week experiment is evaluated by the faculty member and your have transferred all the contents to your record before entering to the lab/workshop.

3. At the beginning of the class, if the faculty or the instructor finds that a student is not adequately prepared, they will be marked as absent and not be allowed to perform the experiment.

4. Bring necessary material needed (writing materials, graphs, calculators, etc.) to perform the required preliminary analysis. It is a good idea to do sample calculations and as much of the analysis as possible during the session. Faculty help will be available. Errors in the procedure may thus be easily detected and rectified.

5. Please actively participate in class and don't hesitate to ask questions. Please utilize the teaching assistants fully. To encourage you to be prepared and to read the lab manual before coming to the laboratory, unannounced questions may be asked at any time during the lab.

6. Carelessness in personal conduct or in handling equipment may result in serious injury to the individual or the equipment. Do not run near moving machinery/equipment's. Always be on the alert for strange sounds. Guard against entangling clothes in moving parts of machinery.

7. Students must follow the proper dress code inside the laboratory. To protect clothing from dirt, wear a lab coat. Long hair should be tied back. Shoes covering the whole foot will have to be worn.

8. In performing the experiments, please proceed carefully to minimize any water spills, especially on the electric circuits and wire.

9. Maintain silence, order and discipline inside the lab. Don't use cell phones inside the laboratory.

10. Any injury no matter how small must be reported to the instructor immediately.

11. Check with faculty members one week before the experiment to make sure that you have the handout for that experiment and all the apparatus.

AFTER THE LABORATORY SESSION

1. Clean up your work area.

2. Check with the technician before you leave.

3. Make sure you understand what kind of report is to be prepared and due submission of record is next lab class.

4. Do sample calculations and some preliminary work to verify that the experiment was successful

MAKE-UPS AND LATE WORK

Students must participate in all laboratory exercises as scheduled. They must obtain permission from the faculty member for absence, which would be granted only under justifiable circumstances. In such an event, a student must make arrangements for a make-up laboratory, which will be scheduled when the time is available after completing one cycle. Late submission will be awarded less mark for record and internals and zero in worst cases.

LABORATORY POLICIES

1. Food, beverages & mobile phones are not allowed in the laboratory at any time.

2. Do not sit or place anything on instrument benches.

3. Organizing laboratory experiments requires the help of laboratory technicians and staff. Be punctual.

SYLLABUS

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME230	FLUID MECHANICS AND MACHINES LABORATORY	0-0-3-1	2016

Prerequisite: ME203 Mechanics of fluids

Course Objectives: The main objectives of this course is to demonstrate the applications of theories of basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.

Syllabus

Study:

1. Study of flow measuring equipments - water meters, venturi meter, orifice meter, current meter, rotameter
2. Study of gauges - pressure gauge, vacuum gauge, manometers.
3. Study of valves - stop valve, gate valve and foot valve.
4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet.
5. Study of Turbines - Impulse and reaction types.
6. Study of Hydraulic ram, accumulator etc.

List of Experiments:

1. Determination of coefficient of discharge and calibration of Notches
2. Determination of coefficient of discharge and calibration of Orifice meter
3. Determination of coefficient of discharge and calibration of Venturimeter.
4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus
5. Determination of hydraulic coefficients of orifices
6. Determination of metacentric height and radius of gyration of floating bodies.
7. Experiments on hydraulic ram
8. Reynolds experiment
9. Bernoulli's experiment
10. Experiment on Torque converter
11. Performance test on positive displacement pumps
12. Performance test on centrifugal pumps, determination of operating point and efficiency
13. Performance test on gear pump
14. Performance test on Impulse turbines
15. Performance test on reaction turbines (Francis and Kaplan Turbines)
16. Speed variation test on Impulse turbine
17. Determination of best guide vane opening for Reaction turbine
18. Impact of jet

Note: 12 experiments are mandatory

Expected outcome: At the end of the course the students will be able to

1. Discuss physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturi meter), and to a variety of problems
2. Determine the efficiency and plot the characteristic curves of different types of pumps and turbines.

1. DETERMINATION OF COEFFICIENT OF DISCHARGE OF GIVEN ORIFICE METER

AIM

To determine the theoretical discharge through the passage using orifice meter and to find the co-efficient of discharge of the given orifice meter.

DESCRIPTION

Orifice meter has two sections. First one is of area a1, and second one of area a2, it does not have throat like venturi meter but a small holes on a plate fixed along the diameter of pipe. The mercury level should not fluctuate because it would come out of manometer.

APPARATUS REQUIRED

1. Orifice meter
2. Differential U tube
3. Collecting tank
4. Stop watch
5. Scale

PROCEDURE

1. Measure the length and breadth of the collecting tank.

L = m & B = m.

2. Open the respective valve in the pipeline and close all the other valves. Adjust the flow suitably

3. Note the left limb reading (h1) and the right limb reading (h2)m of the manometer.

Close the drain valve of the collecting tank.

Find the time taken for 10cm (t) rise of water level in the collecting tank.

4. Repeat the experiment for the different flow rates and through different flow meters

OBSERVATION AND RESULT TABULATION:

Diameter Of The Pipe Inlet (d_1) = m **Length Of The Collecting Tank = m**

Orifice Diameter (d_2) = m **Breadth Of The Collecting Tank = m**

S.NO	MANOMETER READINGS			Diff of head h (m)	Time taken for 10cm rise of water in the tank (T)	Q_{act} m^3/sec	Q_{the} m^3/sec	$Cd = Q_{act} / Q_{the}$
	h_1 (cm)	h_2 (cm)	$h_1 - h_2$ (m)					
							average =	

FORMULAE

1. ACTUAL DISCHARGE

$Q_{act} = A \times R / t$ (m3 / sec)

Where,

A = Area of collecting tank in m^2.

A = L x B m^2

R = Height of collected water in tank = 10 cm (**0.1m**)

t = Time taken for 10 cm rise of water

2. THEORETICAL DISCHARGE

$Q_{the} = K \sqrt{h}$ m^3/sec.

Where,

$K = a_1 \times a_2 \sqrt{2g} / \sqrt{(a_1^2 - a_2^2)}$

a_1 = Area of inlet pipe in, m^2

$a_1 = \pi/4 \times d_1^2$

a_2 = Area of the throat in m^2

$a_2 = \pi/4 \times d_2^2$

g = Specify gravity in m / sec^2

g = 9.81 m/sec^2

h = h1-h2 (sm / s2-1) m of water column.

h_1 = Manometric head in the first limbs (m)

h_2 = Manometric head in the second limbs (m)

S_m = Specific Gravity of Mercury (13.6)

S_w = Specific Gravity of Water (1)

3. CO-EFFICIENT OF DISCHARGE

Cd = Q_{act} / Q_{the} (no units)

RESULT

- **HEAD VS ACTUAL DISCHARGE (Q_{act})**

The difference of head is increased when Q_{act} is increasing.

- **Q_{the} Vs Q_{act}**

The Q_{the} is increased when Q_{act} is increasing.

- **Cd vs Q_{act}**

Cd is increased when Q_{act} is increasing.

The co efficient of discharge through orifice meter is ……… (No unit)

Thus the co efficient of discharge of the given orifice meter is found using the tabulation, calculation and graph.

2. DETERMINATION OF CO EFFICIENT OF DISCHARGE OF GIVEN VENTURIMETER

AIM

To determine the theoretical discharge through the passage using orifice meter and to find the co-efficient of discharge of the given venturi meter.

DESCRIPTION

Venturimeter has two sections. One divergent area and the other throat area. The former is represented as a_1 and the later is a_2 water or any other liquid flows through the venturimeter and it passes to the throat area the value of discharge is same at a_1 and a_2.

APPARATUS REQUIRED

1. Venturi meter
2. Differential U tube
3. Collecting tank
4. Stop watch
5. Scale

PROCEDURE

1. Measure the length and breadth of the collecting tank.

   L = m.

   B = m.

2. Open the respective valve in the pipeline and close all the other valves. Adjust the flow suitably
3. Note the left limb reading (h_1) m and the right limb reading (h_2) m of the manometer.
4. Close the drain valve of the collecting tank.

5. Find the time taken for 10cm (**t**) rise of water level in the collecting tank

6. Repeat the experiment for the different flow rates and through different flow meters

OBSERVATION AND RESULT TABULATION:

Diameter Of The Pipe Inlet (d_1) = m Length Of The Collecting Tank = m

Orifice Diameter (d_2) = m Breadth Of The Collecting Tank = m

S.NO	MANOMETER READINGS			Diff of head h (m)	Time taken for 10cm rise of water in the tank (T) sec	Q_{act} m^3/sec	Q_{the} m^3/sec	$Cd = Q_{act} / Q_{the}$
	h_1 (cm)	h_2 (cm)	$h_1 - h_2$ (m)					
							average =	

FORMULAE

1. ACTUAL DISCHARGE

$Q_{act} = A \times R / t$ (m3 / sec)

Where,

A = Area of collecting tank in m^2.

A = L x B m^2

R = Height of collected water in tank = 10 cm (**0.1m**)

t = Time taken for 10 cm rise of water

2. THEORETICAL DISCHARGE

$Q_{the} = K \sqrt{h}$ m^3/sec.

Where,

$K = a_1 \times a_2 \sqrt{2g} / \sqrt{(a_1^2 - a_2^2)}$

a_1 = Area of inlet pipe in, m^2

$a_1 = \pi/4 \times d_1^2$

a_2 = Area of the throat in m^2

$a_2 = \pi/4 \times d_2^2$

g = Specify Gravity in m / sec^2

g = 9.81 m/sec^2

$h = h_1 - h_2 (s_m / s_2 - 1)$ m of water column.

h_1 = Manometric head in the first limbs (m)

h_2 = Manometric head in the second limbs (m)

S_m = Specific Gravity of Mercury (13.6)

3. CO-EFFICIENT OF DISCHARGE

$$Cd = Q_{act} / Q_{the} \text{ (no units)}$$

RESULT

- **HEAD VS ACTUAL DISCHARGE (Q_{act})**

  The difference of head is increased when Q_{act} is increasing.

- **Q_{the} Vs Q_{act}**

  The Q_{the} is increased when Q_{act} is increasing.

- **Cd vs Q_{act}**

  Cd is increased when Q_{act} is increasing.

The co efficient of discharge through venturi meter is ……… (No unit)

Thus the co efficient of discharge of the given venturi meter is found using the tabulation, calculation and graph.

3. PERFORMANCE TEST AND DRAWING THE CHARACTERISTICS CURVES OF CENTRIFUGAL PUMP

AIM

To study the performance characteristics of a centrifugal pump and to determine the characteristic with maximum efficiency.

DESCRIPTION

PRIMING

The operation of filling water in the suction pipe casing and a portion delivery pipe

for the removal of air before starting is called priming. After priming the impeller is rotated by a prime mover. The rotating vane gives a centrifugal head to the pump. When the pump attains a constant speed, the delivery valve is gradually opened. The water flows in a radially outward direction. Then, it leaves the vanes at the outer circumference with a high velocity and pressure. Now kinetic energy is gradually converted in to pressure energy. The high-pressure water is through the delivery pipe to the required height

APPARATUS REQUIRED

1. Centrifugal pump setup
2. Meter scale
3. Stop watch

PROCEDURE

1. Prime the pump close the delivery valve and switch on the unit
2. Open the delivery valve and maintain the required delivery head

3. Note down the reading and note the corresponding suction head reading

4. Close the drain valve and note down the time taken for 10 cm rise of water level in collecting tank

5. Measure the area of collecting tank

6. For different delivery tubes, repeat the experiment

7. For every set reading note down the time taken for 10 revolutions of energy meter disc

FORMULAE

1. **ACTUAL DISCHARGE**

Q_{act} = A x R / t (m3 / sec)

Where,

A = Area of collecting tank in m^2

A = L x B m^2

R = Height of collected water in tank = 10 cm (**0.1m**)

t = Time taken for 10 cm rise of water

2. **INPUT POWER**

I/P = (3600 x N_r x efficiency) / (E x T) (KW)

Where,

N_r = Number of revolutions of energy meter disc 10

E = Energy meter constant 1600 (rev / Kw hr)

T = time taken for 'Nr' revolutions (seconds) sec

3. OUTPUT POWER:

Po = ρ x g x Q x H / 1000 KW

Where,

ρ = Density of water (kg / m^3)

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

H = Total head of water (m)

TOTAL HEAD

H = Hd + Hs

H = Delivery pressure + Vaccum pressure / p_w x g

Where,

Hd = P x 0.981x 10^{-5}

P = Delivery pressure gauge reading

Since,

1kg/cm^2 = 9.81 x 10^4 N/m^2= 0.981 bar

OBSERVATION AND RESULT TABULATION:

LENGTH OF THE COLLECTING TANK (m)=

BREADTH OF THE COLLECTING TANK (m) =

S.NO	Pressure Gauge Readings (P) Kg/cm^2	Vaccum Gauge Readings (V) Kg/cm^2	Total Head 'H' m of Water	Time taken for 10cm rise of water in the	Time taken for 10rev of energy meter (t)	Discharge Q m^3/sec	Input Power Kw	Output Power Kw	Efficiency %
					average =				

Where,

Hs = V x 1.013 x 10^5 / 760 m of H_2O

V = Vaccum Gauge reading

Since,

1Atm.pr = 1.013 bar = 1 x 10^5 N/m^2 = 760mm of Hg = 10.32 m of H_2O

Where,

Pw = Density of water = 1000 kg/m^3

TOTAL HEAD H = = (P x 0.981x 10^{-5} + (v x 1.013 x 10^5 / 760 m of H_2O) / p_w x 9.81

5. EFFICIENCY:

η = (Output power o/p / Input Power I/p) x 100 %

Where,

O/p = Output power KW

I/ p = Input power KW

RESULT

- ✓ **EFFICIENCY VS DISCHARGE**

  Thus efficiency is increasing when the discharge is decreasing.

- ✓ **INPUT POWER VS DISCHARGE**

  Thus input power is decrease when the Discharge is decreasing

- ✓ **TOTAL HEAD VS DISCHARGE**

  Thus total head is increasing when the discharge is decreasing

Thus the performance characteristics of the given single stage centrifugal pump is observed and the corresponding graphs are drawn.

4.CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF RECIPROCATING PUMP

AIM

To study the performance characteristics of a reciprocating pump and to determine the characteristic with maximum efficiency.

APPARATUS REQUIRED

1. Reciprocating pump
2. Meter scale
3. Stop watch

PROCEDURE

1. Close the delivery valve and switch on the unit
2. Open the delivery valve and maintain the required delivery head
3. Note down the reading and note the corresponding suction head reading
4. Close the drain valve and note down the time taken for 10 cm rise of water level in collecting tank
5. Measure the area of collecting tank
6. For different delivery tubes, repeat the experiment
7. For every set reading note down the time taken for 10 revolutions of energy meter disc

OBSERVATION AND RESULT TABULATION:

Length Of The Collecting Tank = m Stroke Length (L) = m

Breadth Of The Collecting Tank = m Speed Of The Crank (rpm) =

S.NO	Pressure Gauge Readings (P)	Vaccum Gauge Readings (V)	Total Head 'H' m of Water	Time taken for 10cm rise of water in the tank (T) sec	Time taken for 10rev of energy meter (t) sec	Actual Discharge Qact	Theoretical discharge Qthe	% slip	Input Power Kw	Output Power Kw	Efficiency %
					average =						

FORMULAE

1. **ACTUAL DISCHARGE (Q_{act})**

$Q_{act} = A \times R / t$ (m3 / sec)

Where,

A = Area of collecting tank in m^2

A = L x B m^2

R = Height of collected water in tank = 10 cm (**0.1m**)

t = Time taken for 10 cm rise of water

$Q_{the} = aLN / 60\ m^3/sec$

Where,

a = cross sectional area of cylinder = **$a = \pi/4 \times d^2\ m^2$**

L = stroke length in m = 0.045 m

N = crank speed in rpm = 326 rpm

d = diameter of the pipe

3. **SLIP**

$SLIP = (Q_{the} - Q_{act} / Q_{the}) \times 100$

4. **INPUT POWER**

$I/P = (3600 \times N_r \times 1000) / (N_e \times T)$ (W)

Where,

N_r = Number of revolutions of energy meter disc 10

N_e = Energy meter constant 1600 (rev / KW hr)

T = time taken for 'Nr' revolutions (seconds) sec

5. OUTPUT POWER:

$P_o = \rho \times g \times Q \times H / 1000$ N / sec KW

Where,

ρ = Density of water (kg / m^3)

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

H = Total head of water (m)

TOTAL HEAD

H = Hd + Hs

Where,

Hd = Delivery Gauge Reading x 10^4/Density of Water (m)

Density of water = 1000 kg/ m^3

Where,

Hs = (Density of Mercury / Density of Water x Suction Gauge Reading) x 1000 m

Density of Mercury = 13600 kg/ m^3

6. EFFICIENCY

η = (Output power o/p / input power I/p) x 100 %

Where,

O/p = Output power KW

I/ p = Input power KW

RESULT

Efficiency of the pump was calculated. From the graph and tabulation the performance of the reciprocating pump was analyzed.

5. CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF GEAR OIL PUMP

AIM

To draw the characteristics curves of gear oil pump and also to determine efficiency of given gear oil pump.

DESCRIPTION

The gear oil pump consists of two identical intermeshing spur wheels working with a fine clearance inside the casing. The wheels are so designed that they form a fluid tight joint at the point of contact. One of the wheels is keyed to driving shaft and the other revolves as the driven wheel.

The pump is first filled with the oil before it starts. As the gear rotates, the oil is trapped in between their teeth and is flown to the discharge end round the casing. The rotating gears build-up sufficient pressure to force the oil in to the delivery pipe.

APPARATUS REQUIRED

1. Gear oil pump setup
2. Meter scale
3. Stop watch

PROCEDURE

1. The gear oil pump is stated.
2. The delivery gauge reading is adjusted for the required value.
3. The corresponding suction gauge reading is noted.

4. The time taken for ‘N’ revolutions in the energy meter is noted with the help of a stopwatch.

5. The time taken for ‘h’ rise in oil level is also noted down after closing the gate valve.

6. With the help of the meter scale the distance between the suction and delivery gauge is noted.

7. For calculating the area of the collecting tank its dimensions are noted down.

8. The experiment is repeated for different delivery gauge readings.

9. Finally the readings are tabulated

.

.

OBSERVATION AND RESULT TABULATION:

LENGTH OF THE COLLECTING TANK = m

BREADTH OF THE COLLECTING TANK = m

S.NO	Pressure Gauge Readings (P) Kg/cm^2	Vaccum Gauge Readings (V) Kg/cm^2	Total Head 'H' m of Water	Time taken for 10cm rise of water in the tank (T) sec	Time taken for 10rev of energy meter (t) sec	Discharge Q m^3/sec	Input Power Kw	Output Power Kw	Efficiency %
					average =				

FORMULAE

1. **ACTUAL DISCHARGE (Q_{act})**

Q_{act} = A x R / t (m3 / sec)

Where,

A = Area of collecting tank in m^2

A = **L x B** m^2

R = Height of collected water in tank = 10 cm (**0.1m**)

t = Time taken for 10 cm rise of water

2. **INPUT POWER**

I/P = (3600 x N_r x 1000) / (N_e x T) (W)

Where,

N_r = Number of revolutions of energy meter disc 10

N_e = Energy meter constant 1600 (rev / KW hr)

T = time taken for 'Nr' revolutions (seconds) sec

3. **OUTPUT POWER:**

Po = ρ_{oil} x g x Q x H / 1000 KW

Where,

ρ = Density of oil 825 (kg / m^3)

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

H = Total head of oil (m)

TOTAL HEAD

H = **Hd** + **Hs**

H = Delivery pressure + Vaccum pressure / ρ_{oil} x g

Where,

Hd = P x 0.981x 10^{-5}

P = Delivery pressure gauge reading

Since,

1kg/cm^2 = 9.81 x 10^4 N/m^2 = 0.981 bar

Where,

Hs = V x 1.013 x 10^5 / 760 m of H_2O

V = Vaccum Gauge reading

Since,

1Atm.pr = 1.013 bar = 1 x 10^5 N/m^2 = 760mm of Hg = 10.32 m of H_2O

TOTAL HEAD H = (P x 0.981x 10^{-5} + (v x 1.013 x 10^5 / 760 m of H_2O) / ρ_{oil} x 9.81

4. EFFICIENCY:

η = (Output power o/p / Input power I/p)

Where,

O/p = Output power KW

I/ p = Input power KW

RESULT

Thus the performance characteristic of gear oil pump was studied and maximum efficiency was found to be. ………%

6. CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF PELTON WHEEL TEST RIG

AIM

To conduct load test on Pelton wheel turbine and to study the characteristics of Pelton

wheel turbine

DESCRIPTION

Pelton wheel turbine is an impulse turbine, which is used to act on high loads and for generating electricity. All the available heads are classified in to velocity energy by means of spear and nozzle arrangement. Position of the jet strikes the knife-edge of the buckets with least relative resistances and shocks. While passing along the buckets the velocity of the water is reduced and hence an impulse force is supplied to the cups which in turn are moved and hence shaft is rotated

APPARATUS REQUIRED

1. Venturimeter
2. Stopwatch
3. Tachometer
4. Dead weight

PROCEDURE

1. The Pelton wheel turbine is started.

2. All the weight in the hanger is removed.

3. The pressure gauge reading is noted down and it is to be maintained constant for different loads.

4. The Venturi meter readings are noted down.

5. The spring balance reading and speed of the turbine are also noted down.

6. A 5Kg load is put on the hanger, similarly all the corresponding readings are noted down.

7. The experiment is repeated for different loads and the readings are tabulated.

OBSERVATION AND RESULT TABULATION:

Diameter Of The Pipe Inlet (D_1) = m Orifice Diameter (D_2 = m

Length Of The Collecting Tank = m Breadth Of The Collecting Tank = m

SL . NO	INLET PRESSURE	Total head	VENTURIMETER READINGS			Flow ratio Q	SPEED N	WEIGHT OF HANGER T1	WEIGHT OF G BALANCE T2	NET WEIGHT T	TURBINE OUTPUT	IP KW	OP KW
			p_1 (cm)	p_2 (cm)	P_3 (cm)								
									average =				

FORMULAE

1. **VENTURIMETER READING:**

   h = (p1 - p2) x 10

   Where

   P1, P2 - Venturimeter readings in kg /cm^2

2. **TO DETERMINE HEAD**

   Turbine Pressure Gauge Reading = P kg/cm^2

   Total Head, H = p x 10 m of water

3. **INPUT TO THE TURBINE**

   INPUT = 9.81 x Q x H KW

4. **TURBINE OUT PUT**

Break Drum Diameter	= 0.2 m
Rope Diameter	= 0.015 m
Equ Drum Dia	= 0.215 m
Hanger Diameter	= P_o – 1 kg
Weight	= T_1 kg
Spring Load	= T_2 kg
Resultant Load, t	= (T- T_2+T_o) kg
Speed of turbine rpm	= N
Turbine Output	**= 0.0011 NT KW**

5. **TURBINE EFFICIENCY**

   Turbine Efficiency = (Output / Input) x 100

RESULT

Thus the performance characteristic of the Pelton Wheel Turbine is done and the maximum efficiency of the turbine is ………. %

7.CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF FRANCIS TURBINE TEST RIG

AIM

To conduct load test on Francis turbine and to study the characteristics of Francis turbine

APPARATUS REQUIRED

1. Stop watch
2. Tachometer

DESCRIPTION

Modern Francis turbine in an inward mixed flow reaction turbine it is a medium head turbine. Hence it required medium quantity of water. The water under pressure from the penstock enters the squirrel casing. The casing completely surrounds the series of fixed vanes. The guides' vanes direct the water on to the runner. The water enters the runner of the turbine in the dial direction at outlet and leaves in the axial direction at the inlet of the runner. Thus it is a mixed flow turbine.

APPARATUS REQUIRED

1. Stop watch
2. Tachometer

PROCEDURE

1. The Francis turbine is started
2. All the weights in the hanger are removed
3. The pressure gauge reading is noted down and this is to be maintained constant for different loads

4. Pressure gauge reading is ascended down

5. The Venturi meter reading and speed of turbine are noted down

6. The experiment is repeated for different loads and the readings are tabulated.

FORMULAE

1. **VENTURIMETER READING**

Pressure Difference (dh) = (p1 - p2) x 10 m, of water

Venturimeter Equation , Q = 0.0055 dh = 0.5 m^3/sec

Where,

P_1, P_2- Venturi meter readings in kg /cm^2

Determine inlet head of water, **h** = 10(ft x v/760) m of water

Input to the turbine = 1000 QH / 75 hp

= 9.81 QH KW

2. **TURBINE OUT PUT**

Break Drum Diameter	= 0.2 m
Rope Diameter	= 0.015 m
Equ Drum Dia	= 0.215 m
Hanger weight	= 1 kg
Weight	= T_1 kg
Spring Load	= T_2 kg
Resultant Load, t	= (T- T_2+T_o) kg
Speed of turbine **rpm**	= N rpm
Turbine Output	**= (3.14 x Q x N x T) / 75 x 60 m**
	= 0.00011 KW

3. **TURBINE EFFICIENCY**

η = (Output / Input) x 100

OBSERVATION AND RESULT TABULATION:

S.NO	INLET PRESSURE	Total head	VENTURIMETER READINGS p1 (cm)	p2 (cm)	P3 (cm)	Flow ratio Q	SPEED N	WEIGHT OF HANGER T1	WEIGHT OF G BALANCE T2	NET WEIGHT T	TURBINE OUTPUT	IP KW	OP KW
									average =				

RESULT

Thus the performance characteristic of the Francis wheel turbine is done and the maximum efficiency of the turbine is …………. %

8. CONDUCTING EXPERIMENTS AND DRAWING THE CHARACTERISTICS CURVES OF KAPLAN TURBINE TEST RIG

AIM

To study the characteristics of a Kaplan turbine

DESCRIPTION

Kaplan turbine is an axial flow reaction turbine used in dams and reservoirs of low height to convert hydraulic energy into mechanical and electrical energy. They are best suited for low heads say from 10m to 5 m. the specific speed ranges from 200 to 1000

The flow through the pipelines into the turbine is measured with the office meter fitted in the pipeline. A mercury manometer is used to measure the pressure difference across the orifice meter. The net pressure difference across the turbine output torque is measured with a pressure gauge and vacuum gauge. The turbine output torque is determined with the rope brake drum. A tachometer is used to measure the rpm.

APPARATUS REQUIRED

1. Venturi meter
2. Stopwatch
3. Tachometer
4. Dead weight

EXPERIMENTAL PROCEDURE

1. Keep the runner vane at require opening
2. Keep the guide vanes at required opening

3. Prime the pump if necessary

4. Close the main sluice valve and they start the pump.

5. Open the sluice valve for the required discharge when the pump motor switches from star to delta mode.

6. Load the turbine by adding weights in the weight hanger. Open the brake drum cooling water gate valve for cooling the brake drum.

7. Measure the turbine rpm with tachometer

8. Note the pressure gauge and vacuum gauge readings

9. Note the orifice meter pressure readings. Repeat the experiments for other loads

FORMULAE

1. VENTURIMETER READING

Pressure Difference (dh) = (p1 - p2) x 10 m, of water

Venturimeter Equation , Q = 0.0055 dh = 0.5 m^3/sec

Where,

P_1, P_2- Venturi meter readings in kg /cm^2

Determine inlet head of water, **h** = 10(ft x v/760) m of water

Input to the turbine = 1000 QH / 75 hp

= 9.81 QH KW

2. TURBINE OUT PUT

Break Drum Diameter	= 0.2 m
Rope Diameter	= 0.015 m
Equ Drum Dia	= 0.215 m
Hanger weight	= 1 kg
Weight	= T_1 kg
Spring Load	= T_2 kg
Resultant Load, t	= (T- T_2+T_o) kg
Speed of turbine **rpm**	= N rpm
Turbine Output	**= (3.14 x Q x N x T) / 75 x 60 m**
	= 0.00011 KW

3. TURBINE EFFICIENCY

η = (Output / Input) x 100

OBSERVATION AND RESULT TABULATION:

SL NO	INLET PRESSURE	Total head	VENTURIMETER READINGS p_1 (cm)	VENTURIMETER READINGS p_2 (cm)	VENTURIMETER READINGS P_3 (cm)	Flow ratio Q	SPEED N	WEIGHT OF HANGER T_1	WEIGHT OF G BALANCE T_2	NET WEIGHT T	TURBINE OUTPUT	IP KW	OP KW
									average =				

RESULT

Thus the performance characteristic of the Kaplan turbine is done and the maximum efficiency of the turbine is …………. %

9. DETERMINATION OF FRICTION FACTOR OF GIVEN SET OF PIPES

AIM

To find the friction ‘f’ for the given pipe.

DESCRIPTION

When liquid flows through a pipeline it is subjected to frictional resistance. The frictional resistance depends upon the roughness of the pipe. More the roughness of the pipe will be more the frictional resistance. The loss of head between selected lengths of the pipe is observed.

APPARATUS REQUIRED

1. A pipe provided with inlet and outlet and pressure tapping
2. Differential u-tube manometer
3. Collecting tank with piezometer
4. Stopwatch
5. Scale

PROCEDURE

1. The diameter of the pipe is measured and the internal dimensions of the collecting tank and the length of the pipe line is measured.
2. Keeping the outlet valve closed and the inlet valve opened
3. The outlet valve is slightly opened and the manometer head on the limbs h1 and h2 are noted
4. The above procedure is repeated by gradually increasing the flow rate and then the corresponding readings are noted

OBSERVATION AND RESULT TABULATION:

Diameter Of The Pipe(d_1) = m **Length Of The Collecting Tank = m**

Length Of The Pipe(l) = m **Breadth Of The Collecting Tank = m**

S.NO	MANOMETER READINGS			Diff of head h (m)	Time taken for 10cm rise of water in the tank (T) sec	Velocity V m^3/sec	Q_{act} m^3/sec	Friction factor (f)
	h_1 (cm)	h_2 (cm)	$h_1 - h_2$ (m)					
							average =	

FORMULAE

1. FRICTION FACTOR (F)

$$f = 2 \times g \times d \times h_f / l \times v^2$$

Where,

g = Acceleration due to gravity (m / sec^2)

d = Diameter of the pipe (m)

l = Length of the pipe (m)

v = Velocity of liquid flowing in the pipe (m / s)

h_f = Loss of head due to friction (m)

h_f = **h_1-h_2 (s_m / s_{w-1}) m of water column.**

h_1 = Manometric head in the first limbs

h_2 = Manometric head in the second limbs

S_m = specific gravity of mercury (13.6)

S_w = specific gravity of water (1)

2. VELOCITY OF LIQUID FLOWING IN THE PIPE

$V = Q_{act}$ / area m^3/sec

Where,

Area = area of the pipe m^2

$= \pi/4 \times d^2\ m^2$

3. ACTUAL DISCHARGE

$Q_{act} = A \times R / t$ (m3 / sec)

Where,

A = Area of collecting tank in m^2

A = L x B m^2

R = Height of collected water in tank = 10 cm (**0.1m**)

t = Time taken for 10 cm rise of water

RESULT:

1. The frictional factor 'f ' for given pipe =------------- x 10-2 (no unit)

2. The friction factor for given pipe by graphical method = ------------- x 10-2 (no unit)

10. DETERMINE THE COEFFICIENT OF DISCHARGE OF NOTCH

AIM

To determine the coefficient of discharge of ‘ V ‘Notch

DESCRIPTION

Notches are overflow structure where length of crest along the flow of water is accurately shaped to calculate discharge. The bottom edge, over which the liquid flows, is known as sill or crest of the notch and the sheet of liquid flowing over a notch (or a weir) is known as nappe or vein. A notch is, usually made of a metallic plate and is used to measure the discharge of liquids.

APPARATUS REQUIRED

1. Supply Tank,
2. Collecting Tank
3. Pointer, Scale
4. V Notch

PROCEDURE

1. The notch under test is positioned at the end of tank with vertical sharp edge on the upstream side.

2. Open the inlet valve and fill water until the crest of notch.

3. Note down the height of crest level by pointer gauge.

4. Change the inlet supply and note the height of this level in the tank.

5. Note the volume of water collected in collecting tank for a particular time and find out the discharge.

6. Height and discharge readings for different flow rate are noted

Observations:

Breath of tank =

Length of tank =

Height of water to crest level for rectangular notch is =

Height of water to crest level for V notch =

Height of water to crest level for Trapezoidal notch =

Angle of V notch =

Width of Rectangular notch =

Type of Notch	Discharge					Final height reading above width	Head above crest level	C_d
	Initial height in tank	Final height in tank	Difference in height	Volume	Q			

FORMULAE

For V notch the discharge coefficient

$$C_d = \frac{Q}{\frac{8}{15}\sqrt{2gH^{\frac{5}{2}}\tan\left(\frac{\theta}{2}\right)}}$$

Where:-

Q = Discharge

H =Height above crest level

θ= Angle of notch

B = Width of notch

RESULT:

The value of Cd for V-notch……

The value of Cd for rectangular notch……

The value of Cd for trapezoidal notch ……

11. DETERMINE THE FRICTION FACTOR FOR THE PIPES (MAJOR LOSSES)

AIM

To determine the friction factor for the pipes.(Major Losses)

DESCRIPTION

Friction factor in pipes or Major losses:- A pipe is a closed conduit through which fluid flows under the pressure. When in the pipe, fluid flows, some of potential energy is lost to overcome hydraulic resistance which is classified as:-

1. The viscous friction effect associated with fluid flow.

2. The local resistance which result from flow disturbances caused by sudden expansion and contraction in pipe

Obstruction in the form of valves, elbows and other pipe fittings. curves and bend in the pipe.

APPARATUS REQUIRED

1. Supply Tank,
2. Collecting Tank
3. Pipes having different diameter
4. Manometers

PROCEDURE

1. Note down the relevant dimensions as diameter and length of pipe between the pressure tapping, area of collecting tank etc.

2. Pressure tapping of a pipe is kept open while for other pipe is closed.

3. The flow rate was adjusted to its maximum value. By maintaining suitable amount of steady flow in the pipe.

4. The discharge flowing in the circuit is recorded together with the water level in the left and right limbs of manometer tube.

5. The flow rate is reduced in stages by means of flow control valve and the discharge & reading of manometer are recorded.

6. This procedure is repeated by closing the pressure tapping of this pipe, together with other pipes and for opening of another pipe.

Observation:-

Diameter of pipe D =

Length of pipe between pressure tapping L =

Area of collecting tank =

Sr. No.	Manometer Reading			Discharge measurement				**F** **$= \pi^2 gD^5 / 8LQ^2 h_f$**
	Left limb H_1	Right limb H_2	Difference of head in term of water **$h_f = 13.6(H_2-H_1)$**	Initial cm.	Final cm.	Time sec	Discharge Q (cm^3/sec)	

RESULT:

Friction factors:

12. VERIFY THE BERNOULLI'S THEOREM

AIM

To verify the Bernoulli's theorem

DESCRIPTION

Bernoulli's theorem states that when there is a continues connection between the particle of flowing mass liquid, the total energy of any sector of flow will remain same provided there is no reduction or addition at any point

Formula Used:-

$$H_1 = Z_1 + P_1/w + V_1^2/2g$$

$$H_2 = Z_2 + P_2/w + V_2^2/2g$$

APPARATUS REQUIRED

1. Supply tank of water

2. Tapered inclined pipe fitted with no. of piezometer tubes point

3. Measuring tank,

4. Scale

5. Stop watch

PROCEDURE

1. Open the inlet valve slowly and allow the water to flow from the supply tank.

2. Now adjust the flow to get a constant head in the supply tank to make flow in and out flow equal.

3. Under this condition the pressure head will become constant in the piezometer tubes.

4. Note down the quantity of water collected in the measuring tank for a given interval of time.

5. Compute the area of cross-section under the piezometer tube.

6. Compute the area of cross-section under the tube.

7. Change the inlet and outlet supply and note the reading.

8. Take at least three readings as described in the above steps.

	1	2	3	4	5	6	7	8	9	10
Reading of piezometric tubes										
Area of cross section under the foot of each point										
Velocity of water under foot of each point										
$V^2/2g$										
p/ρ										
$V^2/2g + p/\rho$										

RESULT:

13. DETERMINATION OF COEFFICIENT OF DISCHARGE OF A V - NOTCH

AIM

To calibrate a V –notch

DESCRIPTION

NOTCH:

A Notch is regarded as an orifice with water level below its upper edge. Notch is made of a metallic plate and its use is to measure the discharge of liquids. These are used for measuring the flow of water from a vessel or tank with no pressure flow. Since the top edge of the notch above the liquid level serves no purpose therefore a notch may have only bottom edge and sides.

SILL "OR" CREST OF A NOTCH:The bottom edge over which liquid flows is known as Sill or Crest of the notch.

RECTANGULAR NOTCH:The notch which is Rectangular in shape is called as the rectangular notch. Coefficient of discharge (Cd): It is the ratio between the actual discharge and the theoretical discharge. Mathematically

$$Cd = Q_{actual} / Q_{theoratical}$$

$$Q_{theoratical} = 2 / 3 * b * \sqrt{2g} * H^{3/2}$$

$$Q_{actual} = Cd * 2 / 3 * b * \sqrt{2g} * H^{3/2}$$

$$Q_{actual} = k H^{3/2}$$

Taking log on both hand sides:

$$\text{Log } Q = \text{Log } k + 3 / 2 \text{ Log } H$$

Now here

$$\text{Log } k = \text{Intercept}$$

$$K = \log^{-1}(\text{Intercept})$$

&

Also

$$K = 2 / 3 * Cd * b * \sqrt{2g}$$

PROCEDURE

1. Fix the plate having rectangular notch in the water passage of Hydraulic bench.
2. Turn the hydraulic bench on; water will accumulate in the channel.
3. When the water level reaches the Crest or sill of notch stop the inflow and note the reading, and design it as H1.
4. Restart the bench and note the volume and time of water that accumulates in the volumetric tank of bench, from this find the discharge, and also note the height of water at this point.
5. Find H = H2 – H1 This will give you the head over the notch.
6. Find the width of the notch.
7. Take different readings by changing the discharge head over the notch, using the above procedure.
8. Plot a graph between Log10H and Log10Q and find K from graph equation.

Find Cd from the following formula. $Cd = 2 / 3 \times k / \sqrt{2g} \times b$

Observation :

Triangular or V -notch.

Apex angle of Notch ,θ =

Crest Level of trapezoidal notch H1=

Area of collecting tank, a=

S. No.	Discharge Measurement				Final Reading of water level above the notch H_2	Head over notch $H = H_2 - H_1$ (cm)	$C_d =$
	Initial (cm)h_1	**Final (cm)h_2**	**Vol. (cm^3)**	**Vol. (cm^3/sec) Q=vol/t**			

RESULT