I

Name _____

Roll No. _____ Year 20____20____

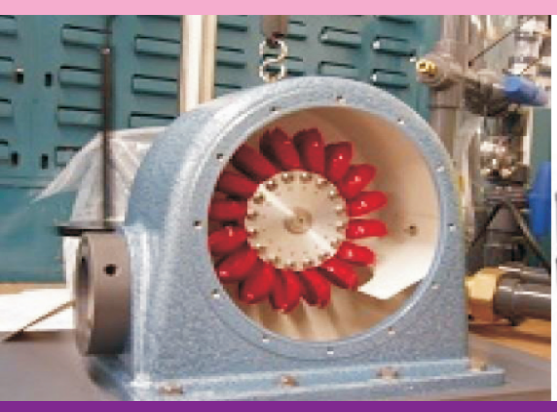
Exam Seat No. _____

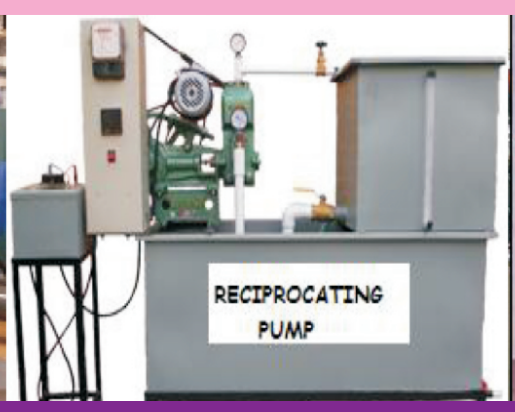
MECHANICAL GROUP | SEMESTER - IV | DIPLOMA IN ENGINEERING AND TECHNOLOGY

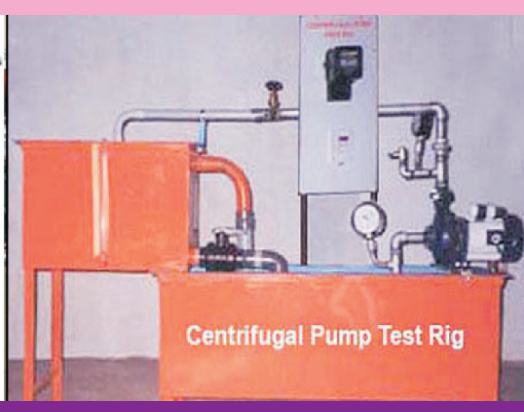
A LABORATORY MANUAL

FOR

FLUID MECHANICS AND MACHINERY (22445)







MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Practical Manual
for

Fluid Mechanics and Machinery

(22445)

Semester– (IV)

(ME)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on November 2018)

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms …….

Roll No…….of Fourth Semester of Diploma in ……. of Institute ……..

(Code……..) has completed the term work satisfactorily in course Fluid Mechanics and Machinery **(22445)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No…….

Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practical to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practical to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Knowledge of fluid properties, fluid flow and fluid machinery is essential in all fields of engineering. Hydraulic machines have important role in water supply, irrigation, power generation and also in most of the engineering segments. This course is intended to develop the skills to estimate loss in pipes, efficiency of hydraulic machines like turbine, pumps etc., head on a pump and select a pump for a particular application, diagnose and rectify the faults in pumps and turbines, replace pressure gauges and other accessories on hydraulic machines turbines, and apply their knowledge in hydraulics to select appropriate devices like pressure gauges, valves, flow devices, pipes etc for different field applications.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course:-

Following POs and PSO are expected to be achieved through the practicals of the (Fluid Mechanics and Machinery) course.

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based mechanical engineering problems

PO 2. **Discipline knowledge:** Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based mechanical engineering problems.

PO 4. **Engineering tools:** Apply relevant mechanical technologies and tools with an understanding of the limitations

PO 5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of mechanical engineering.

PO 6. **Environment and sustainability:** Apply mechanical engineering solutions also for sustainable development practices in societal and environmental contexts.

PO 7. **Ethics:** Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of mechanical engineering

PO 8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO 9. **Communication:** Communicate effectively in oral and written form.

PO 10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the mechanical engineering and allied industry.

Program Specific Outcomes (PSOs)

PSO 1: Modern Software Usage: Use latest mechanical related software for simple design, drafting, manufacturing, maintenance and documentation of mechanical components and processes.

PSO 2: Maintenance and selection of machines, equipment, instruments: Maintain and select appropriate machine, equipment and instrument in field of Mechanical Engineering.

PSO 3: Manage Mechanical Process: Manage the mechanical process by selection and scheduling right type of machinery, equipment, substrates, quality control techniques, operational parameters and software for a particular mechanical process or job for economy of operations.

List of Industry Relevant Skills

The following industry relevant skills of the competency 'Maintain hydraulic machinery using knowledge of fluid mechanics' are expected to be developed in you by undertaking the practical of this laboratory manual.

1. Use pressure measuring devices for measuring pressure of various fluid Devices
2. Maintain Fluid Machinery
3. Operate Fluid machinery
4. Select pressure measuring devices for given application
5. Select flow measuring devices for given applications

Practical- Course Outcome matrix

Course Outcomes (COs)

a. Use Manometers and Bourden gauge to measure pressure.
b. Use flow meters to measure the rate of flow.
c. Maintain flow through pipes.
d. Maintain the jet impact on various types of vanes for optimum efficiency.
e. Maintain hydraulic turbines.
f. Maintain hydraulic pumps.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.	CO f.
1.	Use Bourdon's pressure gauge and U-tube Manometer to measure water pressure also Measure discharge of water using measuring tank and stop watch.*	√	-	-	-	-	-
2.	Measure Total Energy available at different sections of a pipe layout	-	√	-	-	-	-
3.	Use Venturimeter to measure discharge through a pipe*	-	√	-	-	-	-
4.	Use Sharp edged circular orifice to measure discharge through a pipe	-	√	-	-	-	-
5.	Estimate Darcy's friction factor 'f' in pipes of three different diameters for four different discharges	-	-	√	-	-	-
6.	Determine frictional losses in sudden expansion and sudden contraction in pipe.*	--	-	√	-	-	-
7.	Determine frictional losses in bend in pipe.	-	-	√	-	-	-
8.	Determine frictional losses in elbow in pipe.	-	-	√	-	-	-
9.	Determine the force exerted by a jet on flat plate	-	-	-	√	-	-
10.	Use Pelton wheel test rig to determine overall efficiency	-	-	-	--	√	-
11.	Dismantle a Centrifugal pump. *	-	-	-	-	-	√
12.	Assemble a Centrifugal pump.*	-	-	-	-	-	√
13.	Determine overall efficiency of Centrifugal Pump	-	-	-	-	-	√
14.	Dismantle a Reciprocating pump *	-	-	-	-	-	√
15.	Assemble a Reciprocating pump*	-	-	-	-	-	√

16.	Determine overall efficiency of Reciprocating pump using Reciprocating pump test rig.*	-	-	-	-	-	√
17.	Determine percent slip of Reciprocating pump.	-	-	-	-	-	√

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters(if any), which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question banks for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines.

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Technical Manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practical.

Content Page

List of Practical and Progressive Assessment Sheet

16.	Determine overall efficiency of Reciprocating pump using Reciprocating pump test rig.*	106					
17.	Determine percent slip of Reciprocating pump						
Total							

Note: To be transferred to Proforma of CIAAN-2017.

A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

Practical No.1: Measure water Pressure using Bourdon's pressure gauge and U-tube Manometer and discharge of water using measuring tank and stop watch.

I Practical Significance

Pressure measurement is the analysis of an applied force by a fluid on a surface. Pressure is typically measured in units of force per unit of surface area. Many techniques have been developed for the measurement of pressure. Instruments used to measure and display pressure in an integral unit are called pressure gauges.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'Use Bourdon's pressure gauge, Manometer & Discharge measurement instrument'**

IV Relevant Course Outcome(s)

1. Use Manometers and Bourden's gauge to measure pressure.

V Practical Outcome

- Use Bourdon's pressure gauge and U-tube Manometer to measure water pressure.
- Measure discharge of water using measuring tank and stopwatch

VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

Bourdon pressure gauge is used to measure pressure . The pressure to be measured is applied to a curved tube, oval in cross section. Pressure applied to the tube tends to cause the tube to strengthen out .The deflection of the tube is communicated through a system of levers to a recording needle

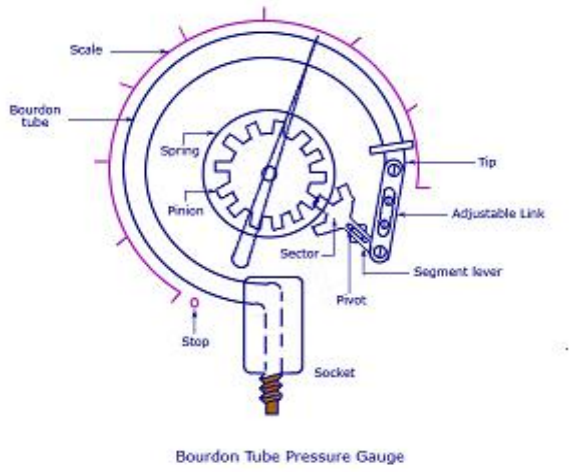


Figure 1- Construction of Bourdons pressure Gauge

U Tube Manometer: A manometer works on the principle of hydrostatic equilibrium and is used for measuring the pressure exerted by a liquid . Hydrostatic equilibrium states that the pressure at any point in a fluid at rest is equal, and its value is just the weight of the overlying fluid. In its simplest form, a manometer is a U-shaped tube consisting of an incompressible fluid like water or mercury. It is inexpensive and does not need calibration.

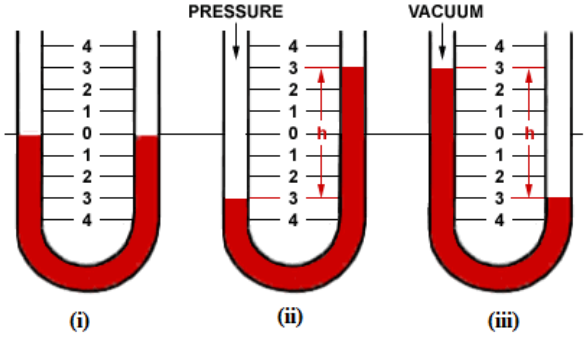


Figure 2- U Tube Manometers

Measurement of Discharge: Discharge is the volumetric flow rate of water. It is commonly expressed in cubic meter per second. Simplest method to measure the discharge of water is with the help of measuring tank.

VIII Experimental setup

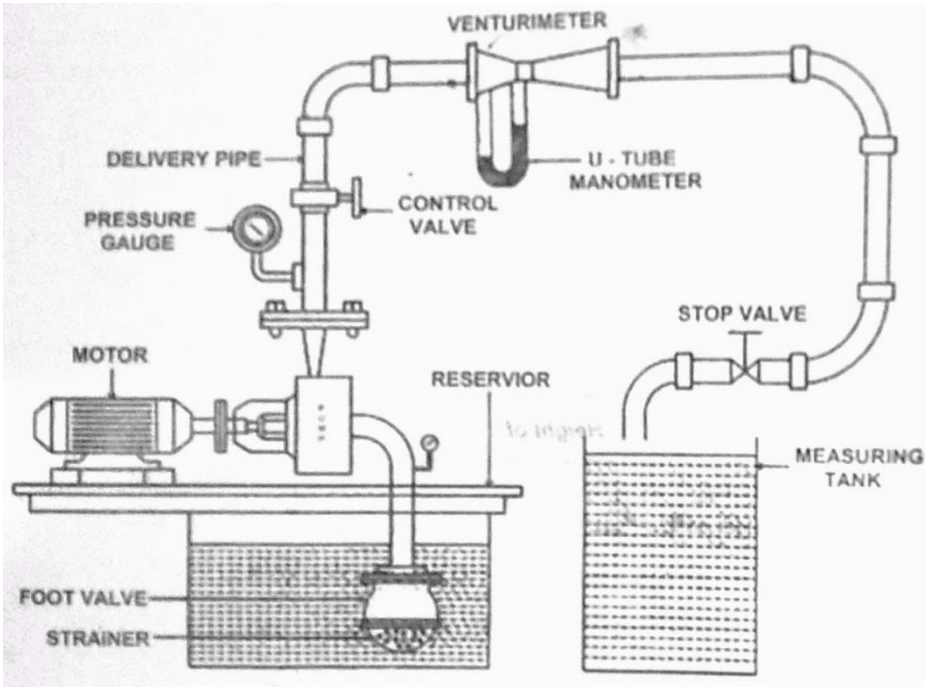


Figure 3 Experimental Set up

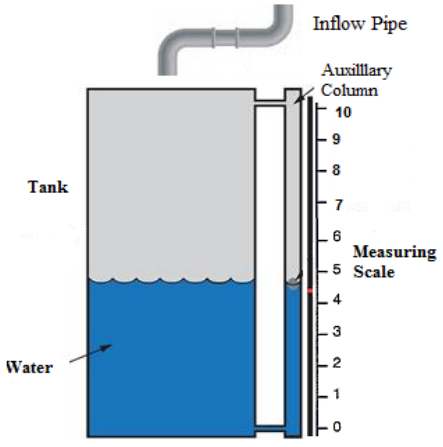


Figure 4: Measuring Tank for discharge Measurement.

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Centrifugal Pump Test Rig along with necessary pipe fitting & Accessories.	**Pump :** 1HP Centrifugal Pump.**DC motor :** 1HP. **Supply Tank :** 80 Ltrs. Made of MS with FRP Lining. **Piping :** GI/PVC	1
2	Bourdon pressure gauge	Range 0 to 12 bar	1

3	Venturimeter	Venturi-meter - 13 mm (Mild Steel)	1
4	U tube manometer	Metering Tube : Special uniform bare thick walled borosilicate glass tube Casing : M.S. /Aluminum Casing from three sides and aluminum cover with transparent acrylic front Zero adjustment scale Wall / Stand mounted	1
5	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
6	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
7	Measuring Scale/steel rule	Range upto 60 cms	1

X Precautions to be Followed

1. Avoid improper handling of electrical connections of Centrifugal pump.
2. Please ensure Priming is required for centrifugal pump or not.
3. Handle the U- tube manometer with due care.
4. Handle the venurimeter pipes with due care.
5. Handle Stop watch carefully.

XI Procedure

For Bourdon Tube Pressure gauge

1. Start the pump and water will flow in the pipe line.
2. Record the indicated units on the gauge.
3. Record the pressure.
4. Adjust & change the flow control valve to other position and record the reading of pressure gauge.

For U Tube Manometer

1. Connect the manometer to pipe through which fluid/water the is flowing
2. Remove air from the limbs of U tube mercury manometer.
3. Note the heights of mercury columns from the right and left limbs
4. Calculate the difference of above two mercury columns
5. Calculate the head in meters of water, meters of liquid and in N/m^2.
6. Repeat step 6 to 9 by adjusting flow control valve/flow rates.

For Discharge Measurement with Measuring Tank

1. Measure the dimensions for calculating cross sectional area of measuring tank
2. Start the pump.
3. Collect the flow of water in the measuring tank similar to tank as shown in the figure 4.
4. Start the stop watch when you start to collect flow of water in the measuring tank.
5. Note the height of water in the tank after pre-decided time.
6. Stop collecting water in the tank

7. Stop the pump.
8. Calculate volume of water collected in the tank
9. Calculate the discharge of water = Volume of Water /Time = cm^3/sec.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations and Calculations.

1. Pressure Gauge reading

Sr No	Pressure Reading In Kg_f / cm^2	Pressure Reading in N /m^2
1		
2		
3		
4		

2. U Tube Manometer reading

S_1= Specific gravity of liquid flowing through pipe (water) = ----------

S_2= Specific gravity of manometer fluid (mercury) = ----------

Reading for finding differential head:

Sr. No.	Height of Hg in cm the left Limb	Height of Hg in cm the left Limb	Difference In meters	Differential head in the meters of water	Differential head in N/m^2
	h_1	h_2	$x= (h_1- h_2)/100$	$H=x(S_2-S_1)/S_1$	P
1					
2					
3					

Calculation of Manometer reading:

For x= ----------cms = ---------- meters.

Differential head in meters of water, H $= \frac{x\ (S1-S2)}{S1}$, =

H= ----------meters.

Pressure Intensity = (P) =W *H

Whrer, W= specific weight of water = 9810 N/m^2

P = --------- * ---------- P = ---------- N/m^2

2. Discharge Measurement reading–

(a) Measuring tank Dimension= Width **W** = ----------cms,

(b) Breadth, **B** = ----------cms

Sr No	Initial Auxiliary tube reading (I_1) in cm	Final Auxiliary tube reading (I_2) in cm	Height of Water in Auxiliary tube $H_1= I_2 - I_1$ cm.	Time Required for collecting Water sec.	Discharge Q m^3/s
1					
2					

3					

Calculation of Discharge Measurement reading.

Volume of Water collected in the tank, **V= W*B* H_1**

V= ---------- cm^3 = ---------- m^3

Time (t) = ----------seconds

Discharge , $Q=\frac{\text{Volume of Water collected}}{\text{Time}}$

$$Q = \frac{V}{t} = \text{----------} = \text{--------}\frac{m3}{sec}$$

XVI Results

Pressure intensity for first flow rate

(i) For Bourdon tube pressure Gauge: - ----------N/m^2

(ii) For Manometer Reading: - ----------N/m^2

(iii) Discharge of water :- ----------m^3/sec

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. A different pressure gauges show following sets of reading
   (i) 50 psi
   (ii) 100 kg_f/cm^2
   15 bar
   Convert it into N/mm^2& N/m^2.

2. Convert the following reading
   (i) -30 mm of Hg into KPa
   (ii) 10 PSI into bar.
3. Calculate pressure of liquid in a pipe of specific gravity 0.8 with the help of simple manometer. Manometer contains mercury (take sp.gravity of Hg =13.6). From common datum ,the reading in the left limb is 0.06m & right limb which is open to atmosphere is 0.15 m.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.slideshare.net/Gauravsingh963/pressure-measuring-devices
2. https://www.youtube.com/watch?v=-9IfpNAESlM
3. https://www.youtube.com/watch?v=HYcuHgSQvyg
4. https://www.youtube.com/watch?v=cq7g3FTsUbY
5. https://www.slideshare.net/hinabhatu/water-measurement-70543237

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	30%
2	Calculation of final readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. ……..
3. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.2: Measure Total Energy at Different Section of a Pipe Layout.

I Practical Significance

Bernoulli's theorem states " For a perfect and incompressible fluid flowing in a continuous stream ,the total energy of a particle remains same while moving from one point to other".

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

- This practical is expected to develop the following skills for the industry identified competency **'Maintain hydraulic machinery using knowledge of fluid mechanics'.**

IV Relevant Course Outcome(s)

1. Apply Bernoulli's theorem and Continuity equation to the given discharge measuring device and data.
2. Choose the relevant discharge measuring device for the given application with justification.

V Practical Outcome

- Measure total energy available at various segment pipe-layouts by calculating potential, kinetic & pressure energy at different section**.**

VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

1. **Energy: -** is defined as the capacity to do work. It exists in various forms and can change from one form to another.
2. **Potential Energy (Potential Head):-** It is the energy possessed by virtue of its position; it is due to configuration or position above some suitable height or datum line. It is denoted by Z.

3. **Kinetic Energy (Velocity Head):** It is energy possessed by a liquid particle by virtue of its motion. It is due to the velocity flowing liquid and is measured as V2/g. Where V is velocity of flow and 'g' is acceleration due to gravity (g= 9.81m/s^2).
4. **Pressure Energy (Pressure Head):-**It is energy possessed by a liquid particle by virtue of its existing pressure. It is due to the pressure of liquid and measured as P /W. Where 'P' is intensity and 'W' is the specific weight of liquid.
5. **Total Energy (Total Head):-** it is the sum of potential energy, kinetic energy and pressure energy. It is denoted by 'E' and mathematically it is expressed as,

   E= Potential Energy+ Kinetic Energy + Pressure Energy

   $$E=Z+\frac{V2}{2g}+\frac{P}{W}$$

VIII Experimental setup

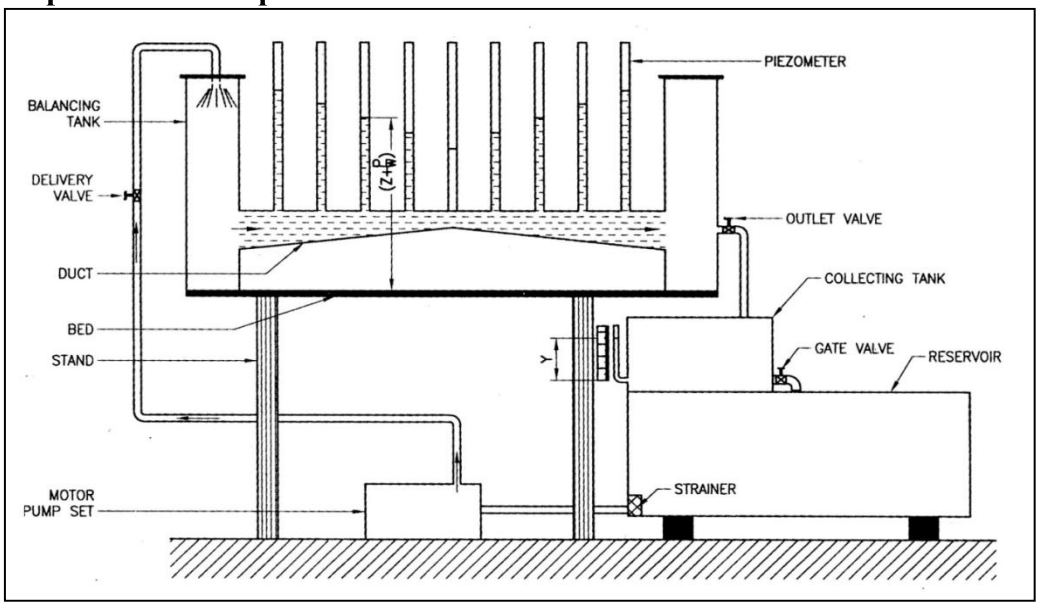

Figure 1 Experimental Set up

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Experimental Set up of Bernoulli's theorem.**	Storage tank: Made up of PVC resist corrosion. Capacity: 100 Ltr. (Approx.), Mono-block pump: 1-phase 1/2 HP, Constant Head Tanks: 2 numbers of suitable size mounted on stand, Differential venturi of 300 mm length made out of Acrylic Square Bar. Multitude Manometer, Material: Aluminum Supporting stand structure for the equipment.	1
2	Pizometer Tubes	Range 0 to 12 bar	1

3	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
4	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
5	Measuring Scale/steel rule	Range up to 60 cms	1

X Precautions to be Followed

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, note the mean position carefully.
2. Carefully keep some level of fluid in inlet and outlet supply tank.
3. Avoid improper handling of electrical connections of Centrifugal pump.
4. Please ensure Priming is required for centrifugal pump or not.
5. Handle the Pizometer tubes with due care.
6. Handle Stop watch carefully.

XI Procedure

1. Start the pump and water will flow in the pipe line.
2. Open the valve so that the water can enter in the pipe of varying cross section.
3. Open the outlet valve after rising water in piezometer,
4. Maintain level of water .
5. Record head shown in the piezometer.
6. Measure discharge in the measuring tank .
7. Note the time taken for collecting of water by stop-watch.
8. Vary the discharge
9. Repeat the procedure as above. .
10. Plot the following graphs:
    i) No. of piezometer tube vs. pressure head.
    ii) No. of piezometer tube vs. velocity head.
    iii) No. of piezometer tube vs. total head.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					

2.					
3.					
4.					
5.					

XIII Actual Procedure Followed

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.....
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XIV Precautions Followed

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.....
.....
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XV Observations and Calculations.

Discharge Measurement reading

Measuring tank Dimension= Width **W** = ----------m , Breadth, **B** = ----------m

Height of water observed in auxiliary tube H_1= ---------- m.

Time required for collecting water = ---------- Seconds.

Calculation of Discharge Measurement reading.

Volume of Water collected in the tank , **V= W*B* H_1**

V= ---------- m^3

Time (t) = ----------seconds

$$\text{Discharge} = Q_d = \frac{\text{Volume of Water collected}}{\text{Time}}$$

$$Q_d = \frac{V}{t} = \qquad\qquad = \frac{\boldsymbol{m3}}{\boldsymbol{S}}$$

Velocity $V = \frac{Qd}{A}$,

Where A= Area at corresponding tube section

Velocity head at respective point = $V^2/2g$ = ----------m.

Pressure Head= P/w = ----------m

Potential head = constant (same datum for all tubes)

For Discharge – Q1 = m^3/sec

Tube No.	**Cross Sectional Area of the Pipe m^2**	**Velocity 'V'** m/sec	**Velocity Head** $\frac{V^2}{2g}$	**Pressure Head** $\frac{P}{w}$	**Total Head= Velocity Head+ Pressure Head** $(V^2/2g) + \frac{P}{w}$
1					
2					
3					
4					
5					
6					
7					
8					
9					

For Discharge – Q2 = m^3/sec

Tube No.	**Cross Sectional Area of the Pipe**	**Velocity 'V'**	**Velocity Head**	**Pressure Head**	**Total Head= Velocity Head+ Pressure Head**
	m^2	m/sec	$\frac{V^2}{2g}$	$\frac{P}{w}$	$(V^2/2g) + \frac{P}{w}$
1					
2					
3					
4					
5					
6					
7					
8					
9					

For Discharge – Q3 = m^3/sec

Tube No.	**Cross Sectional Area of the Pipe**	**Velocity 'V'**	**Velocity Head**	**Pressure Head**	**Total Head= Velocity Head+ Pressure Head**
	m^2	m/sec	$\frac{V^2}{2g}$	$\frac{P}{w}$	$(V^2/2g) + \frac{P}{w}$
1					
2					
3					
4					
5					
6					
7					
8					
9					

XVI Results

(i) Velocity head at respective point = $V^2/2g$ = ----------m.

(ii) Pressure Head= P/W = ----------m

(iii) Total Head = $V^2/2g + P/w$ = ----------m

(Add Graph)

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Water is flowing in a fire hose with a velocity of 1.0 m/s and a pressure of 200000 Pa. At the nozzle the pressure decreases to atmospheric pressure (101300 Pa), there is no change in height. Use the Bernoulli equation to calculate the velocity of the water exiting the nozzle. (Hint: The density of water is 9810 N/m^3 and gravity g is 9.8 m/s^2).
2. Water is flowing at a rate of $2m^3/s$ through a tube with a diameter of 1m. If the pressure at this point is 80 kPa, what is the pressure of the water after the tube narrows to a diameter of 0.5m?
3. Suppose that a huge tank 50 m high and filled with water is open to the atmosphere and is hit with a bullet that pierces one side of the tank, allowing water to flow out. The hole is 2m above the ground. If the hole is very small in comparison with the size of the tank, how quickly will the water flow out of the tank?

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://study.com/academy/lesson/bernoullis-equation-formula-and-examples.html
2. https://oyc.yale.edu/physics/phys-200/lecture-20
3. https://www.youtube.com/watch?v=QnTt9huzdNU
4. https://www.youtube.com/watch?v=DClKlRZKWWk
5. https://www.slideshare.net/eliseb/bernoullis-principle-465993

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	30%
2	Calculation of final readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. …….
3. …….
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.3: Use Venturimeter to Measure Discharge through a Pipe.

I Practical Significance

Venturimeter is a device used for measuring the flow rate. It consists of three parts, Convergent, Throat and divergent cones.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'**Maintain hydraulic machinery using knowledge of fluid mechanics**'.**

IV Relevant Course Outcome(s)

1. Apply Bernoulli's theorem and Continuity equation to the given discharge measuring device and data.
2. Describe with sketches the procedure to calculate discharge using the given flow meter.

V Practical Outcome

- Measure flow rate of fluid flowing through the pipe using venturimeter.
- Apply the concept of coefficient of discharge and interpret its important in flow rate calculation.

VI Relative Affective Domain

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

1. **Discharge:** The volume of liquid flowing per unit time through a section of pipe or channel is known as discharge or flow rate.
2. **A venturi meter** is also called a venturi flow meter. It is used to calculate the velocity of fluids flowing through a pipeline.

Experimental setup

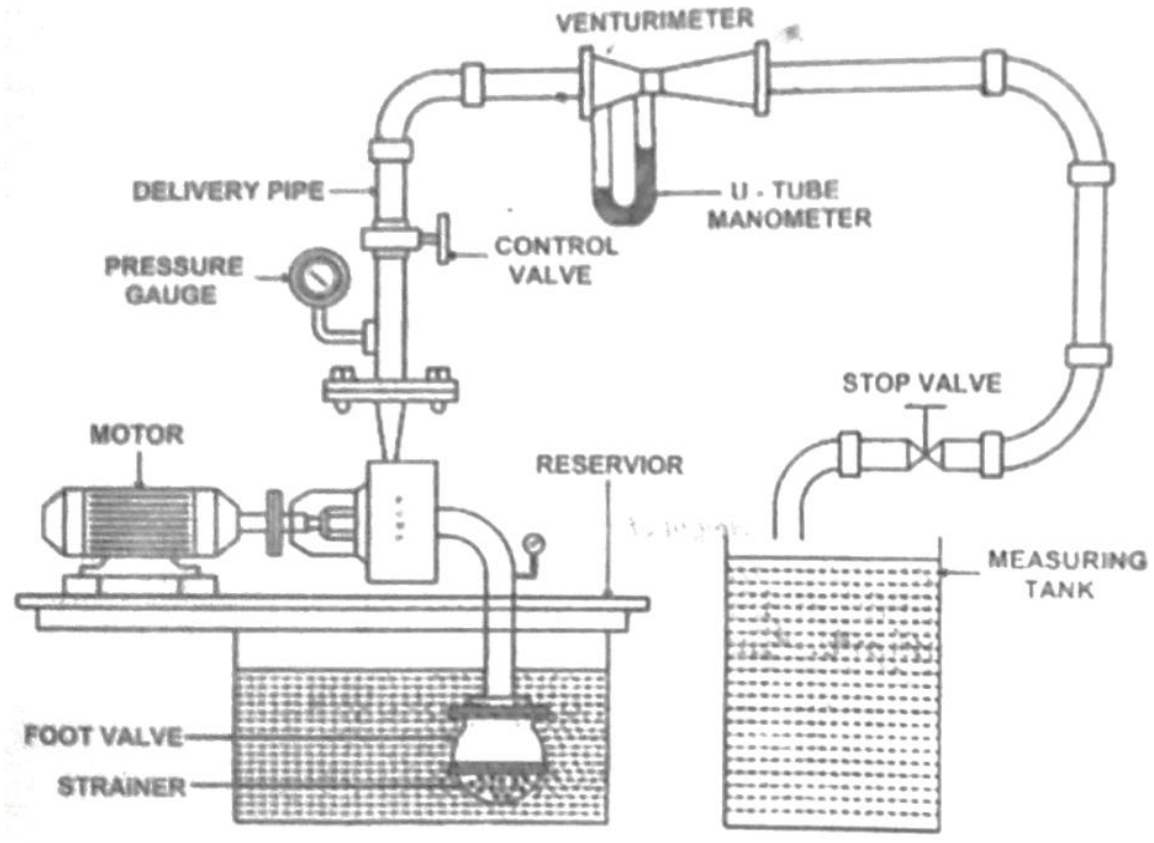

Figure 1 Experimental Set up

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Venturimeter Test Rig consisting of**	**Venturimeter fitted with on the pipe Pump :** 1HP Centrifugal Pump.**DC motor :** 1HP.**Supply Tank :** 80 Ltrs. Made of MS with FRP Lining.**Piping :** GI/PVC.	1
2	U Tube mercury Manometer	It is connected to pipe & Throat section of Venturimeter.	
3	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
4	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
5	Measuring Scale/steel rule	Range upto 60 cms	1

IX Precautions to be Followed

1. Carefully keep some level of fluid in inlet and outlet supply tank.
2. Avoid improper handling of electrical connections of Centrifugal pump.
3. Please ensure Priming is required for centrifugal pump or not.
4. Handle the U tube Manometer tubes with due care.
5. Handle Stop watch carefully.

X Procedure

1. Open the delivery valve of centrifugal pump, to avoid development of sudden pressure.
2. Carry out priming of pump if necessary.
3. Start the pump which allows water to flow through system.
4. Adjust the discharge by control valve.
5. Collect water in a measuring tank to measure the actual discharge.
6. Use stop watch to measure time for collecting water in seconds.
7. Open the two taps simultaneously to connect the venture meter to mercury manometer.
8. Note the height of deflection of mercury column in mercury manometer.
9. Drain the water collected in the measuring tank after each observation.
10. The discharge through the venturimeter can be varied by operating the control valve and repeat the step 4 to 7 for each discharge rate.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
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4.					
5.					

XII Actual Procedure Followed

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XIII Precautions Followed

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XIV Observations and Calculations.

Coefficient of Discharge = C_d= 0.98

Reading of calculation of actual discharge

Sr. No.	Rise of water level of Measuring Tank H_1		Deflection of mercury column of the manometer			Converted water columns height (m) H= H_{hg} (13.6-1)	Time to collect the water in measuring tank (t)
			H_{throat}	H_{pipe}	$H_{hg}=(H_p-H_t)/100$		
	cm	m	cm	Cm	m	m	sec
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Discharge Measurement reading–

Measuring tank Dimension= Width **W** = ----------m, Breadth, **B** = ----------m

Height of water observed in auxiliary tube H_1= ---------- m

Time for collecting water in tank t = ---------- Seconds.

Calculation of Actual Discharge

Volume of Water collected in the tank, **V= W*B* H_1**

V = ---------- m^3

Time (t) = ----------seconds

Diameter of venturimeter at inlet, d1 = mm = m

Cross sectional area a_1 = m^2

Diameter of venturimeter at throat, d2 = mm = m

Cross sectional area a_2 = m^2

Actual Discharge = Q_{act1} = Q = $\frac{\text{Volume of Water collected}}{\text{Time}}$ =

Q = $\frac{V}{t}$ = $\frac{\mathbf{m3}}{\mathbf{sec}}$

Qth = Theoretical Discharge = Qth = $\frac{a1a2\sqrt{2gh}}{\sqrt{a1^2-a2^2}}$

Q_{act2}= C_d* Qth = ----------m^3/sec

Difference between Q_{act1} - Q_{act2} = ---------- m^3/sec

XVI Results

Actual Discharge = ---------- m^3/sec

Qth= Theoretical Discharge = Qth =. $\frac{a1a2\sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ =---------- m^3/sec

Q_{act2}= C_d* Qth = ----------m^3/sec

Difference between Q_{act1}- Q_{act2} = ---------- m^3/sec

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State which relevant discharge measuring device is used in following application (i) To measure the speed of the air around the plane.(ii) To measure the fuel and air

distribution in carburetor (iii) volumetric or mass flow rate determination in chemical & petro chemical plants.

2. State Industrial applications of Venturimeter
3. State the use of venturi in carburetor of automobiles?
4. Write down the effect of changing throat diameter on coefficient of discharge.

[Space for Answer]

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XX Suggestions for Further Reading

1. https://www.youtube.com/watch?v=UNBWI6MV_lY
2. https://www.youtube.com/watch?v=tGQqEZDFVUA
3. https://www.youtube.com/watch?v=YHEPx9m9VXc
4. https://www.youtube.com/watch?v=WvFNqEPNPOc

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. ……..
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical 4: Use Sharp Edged Circular Orifice for Measuring Discharge

I Practical Significance

An orifice plate is a device used for measuring discharge. Volumetric or mass flow rate may be determined, depending on the calculation associated with the orifice plate.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

IV Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'**Maintain hydraulic machinery using knowledge of fluid mechanics **'.**

IV Relevant Course Outcome(s)

1.Use flow meters to measure the rate of flow

V Practical Outcome

- Use Sharp edged circular orifice to measure discharge through a pipe **.**

VI Relative Affective Domain-

- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

An **orifice plate** is a device used for measuring flow rate, for reducing pressure or for restricting flow.

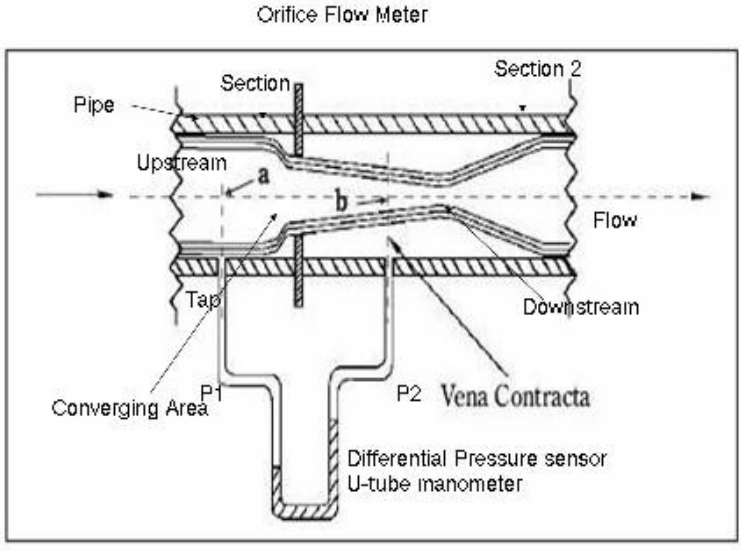

Figure 1: Orifice Meter

1. Vena-contracta:-

Consider an orifice is fitted with a tank. The liquid particles, in order to flow out through the orifice, move towards the orifice from all directions. A few of the particles first move downward, then take a turn to enter into the orifice and then finally flow through it.

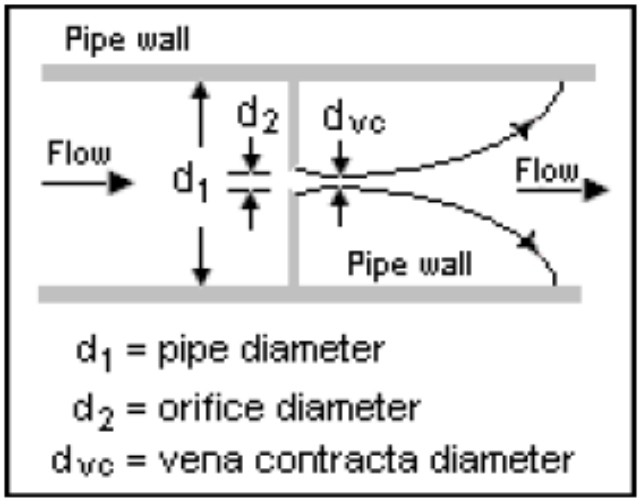

Figure 2: Vena Contracta

2. Coefficient of Discharge:-

For an orifice meter, the discharge coefficient (also known as coefficient of discharge) is the ratio of the actual discharge to the theoretical discharge,

3. **Coefficient of Velocity:-**The ratio of actual velocity of the stream at vena-contract to the theoretical velocity is known as the coefficient of velocity

$$C_v = \frac{v_{act}}{v_{th}}$$

$$= \frac{v_{act}}{\sqrt{2gh}}$$

4. **Coefficient of contraction.** It is the ratio between the area of the jet at the vena contracta to the area of the orifice .

C_c = Area at vena contracta / Area of orifice.

5. **Experimental setup**

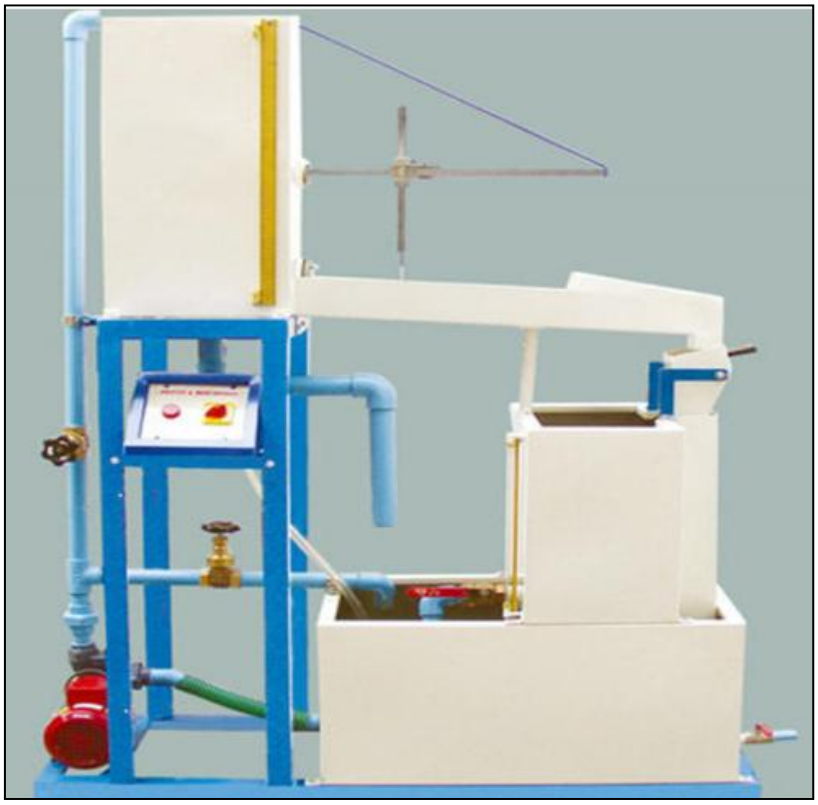

Figure 1 Experimental Set up

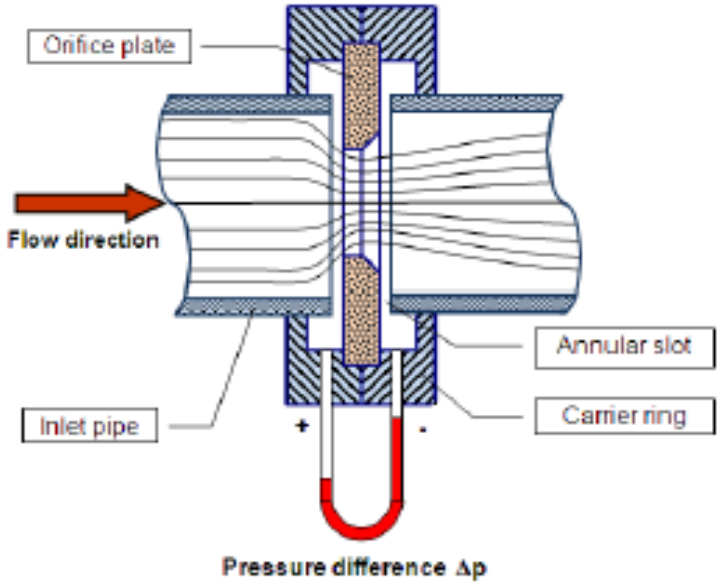

Figure 2- Schematic diagram of Orifice

VIII Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Orifice Meter Test Rig**	**Orifice meter fitted with on the pipe Pump :** 1HP Centrifugal Pump.**DC motor :** 1HP.**Supply Tank :** 80 Ltrs. Made of MS with FRP Lining.**Piping :** GI/PVC.	1
2	U Tube mercury Manometer	It is connected to pipe &orificemeter.	
3	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
4	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
5	Measuring Scale/steel rule	Range upto 60 cms	1

6. Precautions to be Followed

1. Carefully keep some level of fluid in inlet and outlet supply tank.
2. Avoid improper handling of electrical connections of Centrifugal pump.
3. Handle the U tube Manometer tubes with due care.
4. Handle Stop watch carefully.

7. Procedure

1.Switch on the power supply to the pump
2.Adjust the delivery flow control valve
3.Note down manometer heads (h1, h2)
4.Note down time taken for collecting 10 cm rise of water in collecting tank (t).
5.Repeat it for different flow rates.
6. Switch off the pump after completely opening the delivery valve.

IX Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

X Actual Procedure Followed

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XI Precautions Followed

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XII Observations and Calculations.

Sr. No.	Manometer Reading (cm)			Manometer Head In meters	Time taken for 10 cm rise of water level sec	Actual Discharge m^3/s	Theoretical Discharge m^3/s
	h1	h2	h_m=h1-h2	h_m	t	Q_a	Qt
1							
2							
3							

Size of pipe : Inlet Dia. d1 = _____ mm ,

Area of pipe = a_1 = _____ mm^2

Orifice dia d_2 = _____ mm,

Area of Orifice = a_2 = _____ mm^2

The actual Discharge , Qa = A x h / t (m3/sec)

Where A = Area of the collecting tank = length x breadth (m^2)

h = Height of water(10 cm) in collecting tank (m),

t = Time taken for 10 cm rise of water (sec)

The Theoretical discharge through orifice meter,

$Qt= (a_1 a_2 \sqrt{2g H}) / \sqrt{(a1^2 – a2^2)}$ m3/sec

Where, H = Differential head of manometer in m of water

= 12.6 x hm m

g = Acceleration due to gravity (9.81m/sec^2)

Inlet Area of orifice meter in m^2 , $a_1 = \pi d1^2/ 4$,

Area of the throat or orifice in m^2 , $a_2= \pi d2^2/ 4$

Draw graph Qa Vs Qt .

XIII Interpretation of Results

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Scale
X-axis -
Y-axis -

XIV Conclusions

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XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the procedure of measuring actual discharge ,you used in practical
2. Define Vena Contracta.

[Space for Answer]

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XIX Suggestions for Further Reading

1. https://youtu.be/PhXhGf8-KWY
2. https://youtu.be/JXQxdQt3Zac?t=4
3. https://www.youtube.com/watch?v=YrBUN-8tmsY
4. https://www.youtube.com/watch?v=0lm5n7OfxHg
5. https://www.youtube.com/watch?v=if421Ty1qcE
6. https://www.youtube.com/watch?v=4Ce5TOwmSVI
7. https://www.youtube.com/watch?v=oiTHroPw4TM

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.5: Estimate Darcy's friction factor 'f' in pipes of three different diameters for four different discharges.

I Practical Significance

When fluid is flowing through a pipe, it experiences some resistance due to which some of the energy of fluid is lost. Magnitude of frictional losses is used to determine power requirement of pump forcing the fluid through pipe. Head loss due to friction depends upon nature of surface in contact, length of pipe, velocity of flow & diameter of pipe.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency **'**Maintain Hydraulic Machinery using knowledge of Fluid Mechanics**'.**

IV Relevant Course Outcome(s)

1. Use laws of fluid friction for the given Laminar and turbulent flow.
2. Use Darcy's equation for the given frictional losses.
3. Estimate losses in flow for the given pipe layout.

V Practical Outcome

- Apply the concept loss of head in pipe.
- Interpret qualitative information of roughness of pipe into quantitative information in terms of friction factor.
- Determine Darcy's friction factor 'f' in pipes
- Calculate loss of head due to friction in the pipes of different diameters & lengths.
- Regulate the fluid flow.
- Measure discharge of fluid through pipe.
- Operating and recording of time using stop watch.

VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

1. **Frictional Resistance:** The fluid flowing in a pipe is subjected the resistance due to
   (a)Shear forces between fluid particles & boundary walls of the pipe.
   (b)Shear forces among the fluid particles resulting from viscosity of fluid. The frictional resistance causes loss of head (loss of energy).
2. **Head loss due to friction :** It is the difference of pressure head between two distinct points.
3. **Magnitude of head loss:-** Magnitude of frictional losses is used to determine the power requirement of pumps forcing the fluid through the pipe. The Darcy Weisbach has formulated following equation for the magnitude of head loss

$$h_f = \frac{4fl\,v2}{2gd}$$

Where, hf= Head loss due to friction in meters /of liquid column
f= Friction factor (Coefficient of friction)
l= Length of pipe in meters.
v= Velocity of liquid flowing through pipe in m/sec.
d= Diameters of pipe in meters.
g= Acceleration due to gravity in m/s^2.

VIII Experimental setup

Figure 1 Experimental Set up

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Experimental Set up of Darcy's friction factor consist of**	**Pipes (3 Nos.)**: Material GI of ½ ", 1" 1.5" Diameter or equivalent diameters. **Pipe Test Section :** Length 1 m, 1.5m & 2m or equivalent length **Water Circulation Pump** : 1HP Centrifugal Pump.DC motor : 1HP **Sump Tank:** Stainless Steel, Capacity 50 Ltrs. Control Panel : On / Off Switch, Mains Indicator etc. **Measuring Tank:**25 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale with drain valve. **U tube Manometer:**	1
2	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
3	Measuring Scale/steel rule	Range upto 60 cms	1

X Precautions to be Followed

1. Carefully keep some level of fluid in inlet and outlet supply tank.
2. Avoid improper handling of electrical connections of Centrifugal pump.
3. Please ensure Priming is required for centrifugal pump or not.
4. Handle the pipe fitting with due care.
5. Handle Stop watch carefully.
6. Handle U tube manometer carefully.
7. Operate various valve slowly.

XI Procedure

1. Open the valve of centrifugal pump.
2. Open the inlet & outlet valves of first Pipe and close valves of the others.
4. Start the pump and observe flow of water through Pipe
5. Open tapping of manometer connected to this pipe.
6. Measure the rise in level of water in measuring tank for 10 sec .
7. Measure pressure difference by Manometer.
8. Repeat the procedure for 3-4 discharge condition by operating valve of outlet pipe near centrifugal pump.
9. Repeat the step 1 to 8 for remaining pipes

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations and Calculations:

(i) **Material of pipe: - ----------**

(ii) Measuring tank Dimension

Width **W** = ----------m, Breadth, **B** = ----------m

(iii) Area of Measuring tank= Wx B =----------m^2

(iv) Distance between tapping = ----------m.

(v) Specific gravity of fluid in pipe = s_1 = 1 (for water).

(vi) Specific gravity of fluid in manometer = s_2 = 13.6 (for mercury).

Sr. No.	Diameter of pipe	Manometer Reading			$h_f = x \times \frac{(s2-s1)}{s1}$	Rise in height of water in measuring tank H	Time to collect the water in measuring tank (t)	Discharge (Q)= $\frac{W \times B \times H}{t}$	Velocity (v)= Q/A	Darcy's friction factor
		x_1	x_2	$x = x_1 - x_2$						$f = \frac{2gdhf}{4lv^2}$
	m	*m*	*m*	*m*	*m of water*	*m*	*sec*	m^3/sec	*m/sec*	
1										
2										
3										
1										
2										
3										
1										
2										
3										

2. Formula for calculation:

Actual loss of head due to friction (hf) in meters of water column

$hf = x \times \frac{(s2-s1)}{s1}$ = ----------m of water, Where x= manometer reading in meter

s_1= Specific gravity of water

s_2= Specific gravity of mercury

Actual Discharge = $Q = \frac{\text{Volume of Water collected}}{\text{Time}} =$

$$(Q) = \frac{W \; x \; B \; x \; H}{t} = \text{---} \quad = \frac{m3}{sec}$$

Velocity of flow= $v = \frac{4Q}{\pi d^2}$ *m/sec*

Now $hf = \frac{4fl\,v^2}{2gd}$

Friction factor $f = \frac{hf \; X \; 2gd}{4l \; v^2}$

h_f = *Head loss due to friction can be calculated as* = $\frac{flQ^2}{3d^5}$

XVI Results

For given value pipe diameter d_1, d_2, d3 The average value of Darcy's friction factor are found to be f_1= ---------- f_2= ---------- f_3= ----------

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1) If Viscosity of fluid flowing through the pipe is more how it affects friction loss?
2) State the effect of temperature of liquid on friction losses?
3) Will the horizontal or vertical position of pipes affect the friction losses?

[Space for Answer]

XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=YrBUN-8tmsY
2. https://www.youtube.com/watch?v=0lm5n7OfxHg
3. https://www.youtube.com/watch?v=if421Ty1qcE
4. https://www.youtube.com/watch?v=4Ce5TOwmSVI
5. https://www.youtube.com/watch?v=oiTHroPw4TM

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	30%
2	Calculation of final readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.6, 7, 8: Determine Frictional Losses in Sudden Expansion and Sudden Contraction in Pipe

i. Determine Frictional Losses In Bend In Pipe.
ii. Determine Frictional Losses In Elbow In Pipe.

I Practical Significance

Minor losses are the losses of head due to large number of pipe fittings such as bends, elbows, joints, valves, sudden expansion and contraction in pipe diameter. In a pipeline these fittings cause localized energy losses (pressure head) due to their shape and these losses are classified as minor losses..

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency "***Determine minor frictional losses in the fluid flow system"***

- Find the loss of head in the pipe due to various fittings.
- Make the connection of bend, elbow, coupling & reducer etc.
- Connect U tube manometer tubes at the required place between the required pipe fittings.
- Operate pump & valve.

IV Relevant Course Outcome(s)

1. Maintain flow through pipes.
2. Estimate losses in flow for the given pipe layout.

V Practical Outcome

- Find the loss of head in the pipe due to sudden expansion.
- Find the loss of head in the pipe due to sudden expansion.
- Determine frictional losses in bend in pipe.
- Determine frictional losses in elbow in pipe.

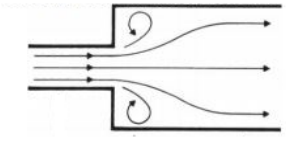
VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

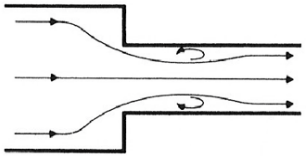
1. **Minor losses:** These are the losses of head due to large number of pipe fitting such as bends, elbows, joints, valves, sudden expansion and contraction in pipe diameter. In pipe fitting these losses are also occurred at entry & exit of pipe. These causes localized energy losses due to their shape and are classified as minor losses. Minor losses are usually neglected, as they are insignificant if they are less than 5% of the frictional losses.
2. **Loss of head due to sudden expansion:** This is energy loss due to sudden enlargement. Sudden enlargement in diameter of pipe results in formation of eddies by the flowing fluid at the corners of enlarged pipe. Because of eddies formation, loss of head takes place. Mathematically it is written as this results in loss of head which is equal to

$$\mathbf{H_e} = \frac{(V1-V2)^2}{2g}$$

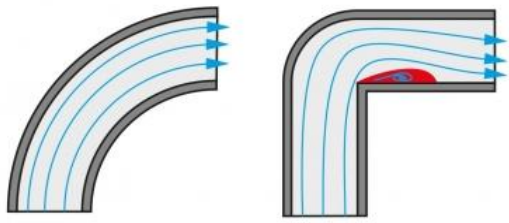


3. **Loss of head due to sudden contraction:** This is energy loss due to sudden contraction. It does not takes place due to sudden contraction but due to sudden enlargement which takes place just after vena contracta. Mathematically it is written as

$$\mathbf{H_e} = \frac{0.5\,V^2}{2g}$$



4. **Loss of head due to bend or elbow in pipe:** This is energy loss due to bend or elbow**.** When bend or elbow is provided in the pipe, there is change in the direction of velocity of liquid. Due to this liquid separates from wall of bend and formation of eddies takes place.



Mathematically it is written as

$$H_b = \frac{k\,V^2}{2g}$$

Where, *k*= Coefficient of bend or elbow.

VIII Experimental setup

Figure 1 Experimental Set up

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	**Experimental Set up for minor frictional losses**	**The apparatus consists of:** • A Centrifugal pump of 25mm x 25mm with 1/2 HP Motor M.S. Sump Tank 80 Ltr. to collect the water. • M.S. Measuring Tank 30 Ltr fitted with piezometer tube to measure the discharge. • G.I. pipe of internal dia 25mm and Gunmetal ISI mark Control Valve and regulating valves are used to circulate water. • Bye-pass line is also used to regulate the discharge. • Large bend made up of G.I. • Sudden enlargement from 25mm dia to 32mm dia. • Sudden contraction from 32mm dia to 25mm. • Gunmetal gate valve of 25mm dia. A U tube manometer is connected to pet cock through plastic tubing to measure head difference. The tanks are well •	1
2	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
3	Measuring Scale/steel rule	Range upto 60 cms	1

X Precautions to be Followed

1.Handle the pipe fitting like elbow, bend etc. with due care.

2.Observe that bubbles are not present in the plastic tube connected to manometer.

3.Open the delivery valve of centrifugal pump, to avoid development of sudden pressure.

4.Avoid improper handling of electrical connections of Centrifugal pump.

5.Please ensure priming is required for centrifugal pump or not.

6.Handle Stop watch carefully.

XI Procedure

a. Open the delivery valve of centrifugal pump.

b. Carry out priming of pump if necessary.

c. Adjust inlet & outlet valve such that **'sudden enlargement arrangement'** of pipe is only connected.
d. Connect point 1 and 2 on the given pipe circuit to the manometers limbs
e. Start the pump which allows water to flow through Storage tank.
f. Adjust the discharge by control valve stop valve and ensure steady flow in system.
g. Note the difference of levels of the mercury columns.
h. Collect water in a measuring tank to measure the actual discharge for 30 seconds (or suitable for set up)
i. Use stop watch to measure time 'T'.
j. Drain the water collected in the measuring tank after each observation.
k. Adjust inlet & outlet valve such that **'sudden contraction arrangement'** of pipe is only connected.
l. Repeat the step 4 to 7 for when **'sudden contraction arrangement'** is connected in system.
m. Adjust inlet & outlet valve such that **'Elbow fitting'** in the pipe is only connected.
n. Repeat the step 4 to 7 for when **'Elbow fitting** 'is connected in system.
o. Adjust inlet & outlet valve such that **'Bend fitting** 'in the pipe is only connected.
p. Repeat the step 4 to 7 for when **'Bend fitting** 'is connected in system

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations and Calculations.

Sr. No.	Nature of pipe fitting	Inlet & Exit diameter of pipe		Manometer Reading		Pressure Difference	Actual Head Lost in meters of water column height $H=H_{hg}$ (13.6-1)	Rise of water level of Measuring Tank in 10 sec
				H_1	H_2	$H_{hg}=(H_2-H_1)/100$ Meters of Hg		
		m	m	cm	cm	m	m	m
1	Sudden Enlargement	Inlet	Exit					
2	Sudden Contraction							
3	Bend							
4	Elbow							

3. Discharge Measurement reading

Measuring tank Dimension= Width **W** = ----------m, Breadth, **B** = ----------m

Height of water observed in auxiliary tube H_1= ---------- m

Time required for collecting water = ---------- seconds.

For Sudden enlargement:

Diameter of pipe at entry, d_1 = ----------m

Diameter of pipe at enlargement, d_2 = ----------m

For Sudden Contraction:

Diameter of pipe at entry, d_3 = ----------m

Diameter of pipe at contraction, d_4 = ----------m

Angle of bend 90^0, diameter of pipe d_5= ----------m

Diameter of pipe at elbow d_6 = ----------m

Calculation of Discharge Measurement reading.

(i) Actual Discharge = Q_{act} = $\frac{\text{Volume of Water collected}}{\text{Time}}$ = **W*B* H_1/ t**

$Q_{act} = \frac{V}{t}$ = ----------m^3/sec

Case I- Loss of head due to sudden enlargement

a. Velocity of water at entry $V_1 = Q/A_1 = \frac{\pi}{4} \times d_1^2$

= ----------m/sec

b. Velocity of water at Outlet $V_2 = Q/A_2 = \frac{\pi}{4} \times d_2^2$

= ----------m/sec

c. Theoretical loss of head due to sudden enlargement: H_e

$H_e = \frac{(V1-V2)^2}{2g}$

= ---------- m of water

Case II- Loss of head due to sudden Contraction

1. Velocity of water at entry $V_3 = Q/A_3 = \frac{\pi}{4} \times d_3^2$

= ----------m/sec

2. Velocity of water at Outlet $V_4 = Q/A_4 = \frac{\pi}{4} \times d_4^2$

= ----------m/sec

3. Theoretical loss of head due to sudden Contraction: H_c

$$H_c = \frac{0.5\ V4^2}{2g}$$

= ---------- m of water

Case III: - Bend

1. Actual Loss of head due to Bend Hb_{act}= ---------- m of water (from observation table)

2. Theoretical Loss of head due to Bend = $H_b = \frac{k\ V5^2}{2g}$

3. Velocity of water flowing through bend = $V_5 = Q/A_5 = \frac{\pi}{4} \times d_5^2$ = ----------m/sec

Equating actual loss of head = Theoretical loss of head

$$H_b == \frac{k\ V_5^2}{2g} = \text{----------}$$

Constant for bend k = H_b act x 2g / $V5^2$ = ----------

Case III: - Elbow

1. Actual Loss of head for given Elbow $H_{el\ act}$= ---------- m of water (from observation table)

2. Theoretical Loss of head due to Elbow = $H_{el\ th} = \frac{k\ V_6^2}{2g}$

3. Velocity of water flowing through Elbow = $V_6 = Q/A_6 = \frac{\pi}{4} \times d_6^2$ = ----------

m/sec

Equating actual loss of head = Theoretical loss of head

$$H_{el} == \frac{kel\ V_6^2}{2g} = \text{----------}$$

Loss coefficient of Elbow 'k_{el}' = 2 g H_{el} / V_6^2

4. Constant for Elbow *L*= He act x 2g / $V6^2$

= ---------- m of water

Result

Case I- For sudden enlargement

Actual Loss of head = ---------- m of water

Theoretical Loss of head = ---------- m of water

Case II- For sudden Contraction

Actual Loss of head = ---------- m of water

Theoretical Loss of head = ---------- m of water

Case III:-Constant for Bend k= ----------

Case IV:-Constant for Elbow k_{el}= ----------

XVI Interpretation of Results

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XVII Conclusions

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XVIII Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1.What is compound pipe? State its use.

2.Compare pipes in series & pipes in parallel (any two).

3.How water hammer can be minimized?

4.For two cases of flow in a sudden contraction in the pipe line & flow in a sudden expansion of pipe line , draw the flow pattern, Hydraulic gradiant line (HGL) & Total energy line(TEL)

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XIX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=6DFe8eUrbcI
2. https://www.youtube.com/watch?v=WMtiH5LyOYI
3. https://www.youtube.com/watch?v=6jClbqlGctY
4. https://www.youtube.com/watch?v=IcJOkRZPNMI

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.9: Determine The Force Exerted By A Jet On Flat Plate

I Practical Significance

Analysis & design of hydraulic machines (turbine and pumps) is essentially based on forces exerted by moving fluids. When a jet of water flowing with a steady velocity strikes a solid surface the water is deflected to flow along the surface. In this practical , we measure the force generated by a jet of water striking a flat plate , and compare the results with the computed momentum flow rate in the jet. This practical investigates the reaction force produced by the impact of a jet of water on to various target vanes so that work done by impact of jet can be calculated.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.
PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency' ***Determine the force exerted and work done by a jet on flat plate& verify the momentum equation experimentally.***

a. Measure the discharge of jet of water.
b. Measure the Velocity of jet of water.
c. Calculate area of nozzle.
d. Calculate force of jet of water.
e. Determine work done by jet of water.

IV Relevant Course Outcome(s)

- Apply impulse momentum equation to the given geometry of vanes and find equation for force and work done.
- Calculate force exerted by a jet and work done for the given flat plate (vane).

V Practical Outcome

- Evaluation of force exerted by a free jet (constant pressure throughout) on flat plate (vane)
- Calculate work done exerted by a jet on flat plate (vane)

VI Relative Affective Domain-

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.

- Maintain tools and equipment.
- Follow ethical Practices.

VII Minimum Theoretical Background

Jet of water: - A **jet** is a stream of fluid that is projected into a surrounding medium, usually from some kind of a nozzle, aperture or orifice etc. Jets can travel long distances without dissipating. Jet fluid has higher momentum compared to the surrounding fluid medium.

Impact of Jet: - The force generated by a jet of water deflected by an impact surface is measured and compared to the momentum change of the jet. The jet of water from the nozzle impinges on the impact surface.

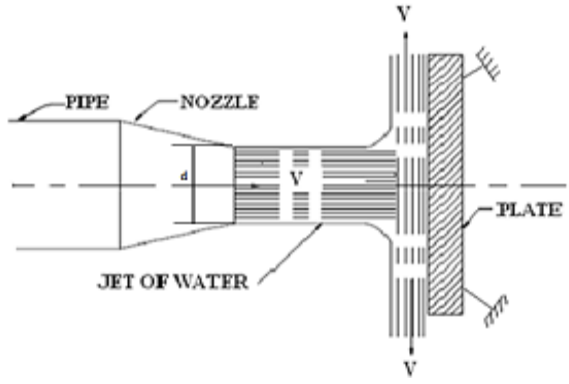

Fig -1

The force exerted by jet on the flat plate in the direction of jet

Fx= Rate of change of momentum in the direction of force

$$\frac{\text{Intial momentum}-\text{final momentum}}{\text{time}} = \frac{\text{Mass (Intial velocity – Final Velocity)}}{\text{time}}$$

$$Fx = \frac{\text{Mass}}{\text{Sec}} x \frac{\text{(velocity of Jet before Striking – Velocity of jet after striking)}}{time}$$

$$\mathbf{F_x = \rho \times a \times V\ (V-0) = \rho\ a\ V^2}$$

VIII Experimental setup

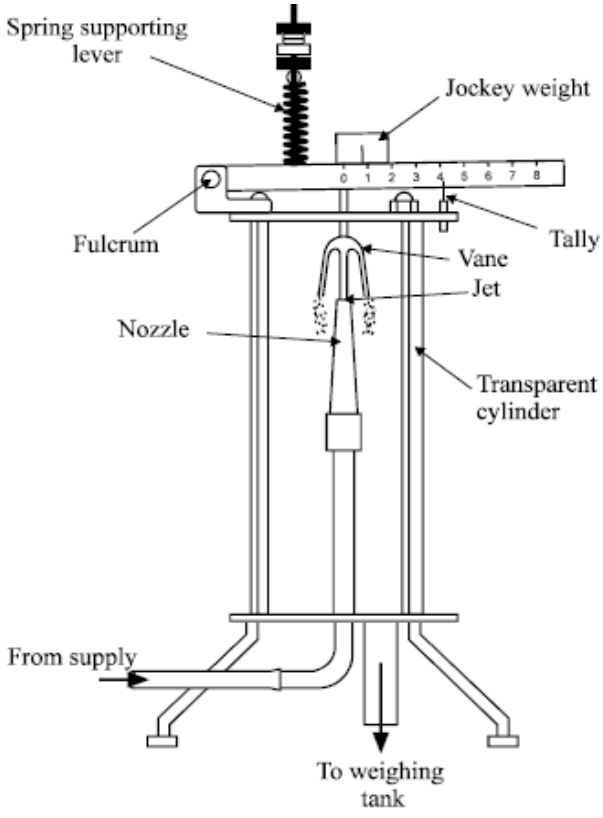

Figure 2 Experimental Set up

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Impact of Jet experimental set up	Plexi glass diameter cylindrical tank, 5 mm diameter Nozzle, 8 mm diameter Nozzle, Impact object of flat shape having 30 mm diameter, Nozzle distance – impact object:-20mm,. Set of stain steel weight.	1
2	Measuring Tank	40 Liters. Made of MS with FRP Lining and fitted with piezometer tube & scale.	1
3	Stop watch	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	1
4	Measuring Scale/steel rule	Range upto 60 cms	1

X Precautions to be Followed

1. Avoid improper handling of electrical connections of Centrifugal pump.
2. Please ensure Priming is required for centrifugal pump or not.
3. Handle the U tube manometer with due care.
4. Handle the venurimeter pipes with due care.
5. Handle Stop watch carefully.

XI Procedure

1. Note down the relevant dimensions as area of collecting tank and diameter of nozzle.
2. When jet is not running, note down the position of upper disc or plate.
3. Admit water supply to the nozzle.
4. As the jet strikes the disc, the disc moves upward, now place the weights to bring back the upper disc to its original position.
5. At this position find out the discharge and note down the weights placed above the disc.
6. The procedure is repeated for different values of flow rate by reducing the water supply in steps.

For Discharge Measurement with Measuring Tank

1. Measure the dimension of measuring tank (i.e. Width, $\mathbf{W_1}$& Breadth, **B**) in centimeters.
2. Collect the flow of water in the measuring tank.
3. Start the stop watch when you start to collect flow of water in the measuring tank.
4. Collect the water in the tank up to pre-decided time (i.e. for 2 or 3 or 5 minutes).
5. Stop to collect the water after completion of pre-decided time.
6. Record height of water, H_1collected on the auxiliary glass tube fixed on the measuring tank.
7. Calculate volume of water collected (i.e W_1*B*H).
8. Calculate the discharge of water Q= Volume of Water /Time = cm^3/sec.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations and Calculations.

Discharge Measurement reading

Measuring tank Dimension= Width **W** = ----------m, Breadth, **B** = ----------m

Time Considered for collecting water = ---------- seconds.

Height of water observed in auxiliary tube H_1= ---------- m

Diameter of Nozzle = ----------m

Volume of Water collected in the tank **V= W*B* H_1**

V= ---------- m^3

Time (t) = ----------seconds

Discharge = Q= $\frac{\text{Volume of Water collected}}{\text{Time}}$

Q= $\frac{V}{t}$= ---------= ---------$\frac{m^3}{sec}$

Sr. No.	Dis-charge Q	Balancing		Height of target above nozzle (h)	Jet Velocity Vo= Q/A	Final Velocity V_1= $\sqrt{Vo^2 - 2gh}$	Theoretical Force Fth = mV_1	Work done = F_{act} x V_1	Error %
		Mass (m)	Experimental Force Fact=mg						
	m^3/sec	**Kg**	**N**	**mm**	**m/sec**	**m/sec**	**N**	**N-m/sec**	**%**
1				20					
2				20					
3				20					
4				25					
5				25					

XVI Results

Discharge ----------m^3/sec.

Theoretical Force = ----------N & Error in balancing ------% (for 20mm Nozzle diameter)

Theoretical Force = ----------N & Error in balancing ------% (for 25mm Nozzle diameter)

Theoretical Force = ----------N & Error in balancing ------% (for 30mm Nozzle diameter)

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the effect of change in diameter of nozzle jet (from 5mm to 8mm) on work done by impact of jet.
2. State the principle of impulse momentum .

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=tXLI-IeAynI
2. https://www.youtube.com/watch?v=dcyRHnrFMhU

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	15%
4	Conclusions	15%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.10: Use Pelton wheel test rig for determining overall efficiency.

I. Practical Significance

Pelton wheel is an impulse turbine. In the Pelton turbine water jets impacts on the blades of the turbine. The turbine is used to rotate the wheel to produce torque and power.

II. Relevant Program Outcomes (Pos)

PO1- Basic Knowledge: Apply knowledge of discharge measurement using Venturimeter to measure pressure at inlet of pipe, pressure head , load on turbine and speed of turbine with the help of tachometer.

PO3- Experiments and practice : Plan to perform experiments and practices to use the results to solve net head on turbine (H), Input power to Pelton Wheel, Resultant load on turbine, Torque on turbine and Output power from the Pelton Wheel.

III Competency and Skills:

The aim of this practical is to help the student to attain the following identified competency through various teaching learning experiences required at the Hydraulic power plant/station.

- **Maintain hydraulic machinery using knowledge of fluid mechanics.**

1. Ability to operate the Pelton Wheel.
2. Ability to measure Pressure at inlet of pipe.
3. Measure speed of turbine with the help of tachometer.
4 Ability to measure input and output power.

1V. Relevant Course Outcome(s)

- Operate the Pelton Wheel with variable opening of penstock
- Measure its input and output power
- Calculate the Overall efficiency of turbine.

V. Practical Outcome.

- Measure pressure at inlet of pipe , speed of turbine , output
- Power and determine overall efficiency of Pelton wheel.

VI. Relevant Affective Domain related Outcomes.

1. Maintain pressure gauges and tachometer.
2. Follow safe practices.
3. Practice energy conservation.

VII. Minimum Theoretical Background.

The Pelton wheel is an impulse turbine in which vanes, sometimes called buckets, of elliptical shape are attached to the periphery of a rotating wheel, as shown in Fig1.One or two nozzles project a jet of water tangentially to the vane pitch circle.In the impulse turbines the available head is converted into the kinetic energy. The jets

issuing from the nozzles strike vanes attached to the periphery of a rotating wheel. Because of the rate of change of angular momentum and the motion of the vanes, work is done on the runner (impeller) by the fluid and, thus, energy is transferred. Hydraulic efficiency is the ratio of power developed by the runner (Pelton wheel) to the net power supplied by the water at the entrance of the turbine.

VIII. Experimental setup.

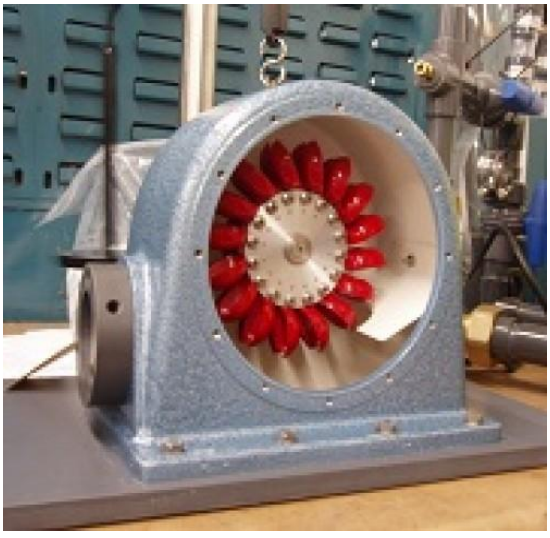

Figure No 1 Pelton wheel

IX. Resources required.

S.No.	Name of Resource	Specifications	Quantity
1.	Pelton wheel test rig consists of, 1. Pelton Wheel 2. Centrifugal Pump. 3. Venturimeter. 4. U-tube differential manometer. 5. Suitable arrangement of water supply and storage.	Design Speed - 750-900 RPM. Output Power - 3.7 kW. (5.0 HP) design Head and discharge - 46-50m and 700-900 lpm	01
2.	Tachometer	Range 0 t0 3000rpm	01
3	Pressure gauge		01

X. Precautions to be Followed

1. Avoid parallex while taking the manometer readings.
2. Tachometer should be placed perfectly perpendicularly while taking the reading.

XI. Procedure

1. Complete the priming of Centrifugal pump, if required and start the pump.
2. Open the regulating valve
3. Observe flow of water through the nozzle.
4. Note the reading of pressure gauge.
5. Note the readings of manometer.
6. Adjust the spear for $1/4^{th}$ gate opening.
7. Apply dead loads on the hanger of dynamometer
8. Note readings of spring balance
9. Measure speed of turbine by Tachometer.
10. Change the position of regulating valve so as to increase the flow rate towards the buckets.
11. Repeat steps 3 to 8 for half, three quarter & full gate opening.
12. Stop the pump. Fully open the regulating valve.

XII. Resources Used.

S.No	Name of Resource	Broad Specifications		Qty	Remarks (if any)
		Make	Details		
1.					
2					
3					

XIII. Actual Procedure Followed.

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XIV. Precautions Followed.

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XV. Observations and Calculations

Sr. No.	Gate Opening	Pressure Head		Manometer Reading			Load applied on turbine		Speed of turbine N
		p	H= p x 10	Left Limb h_1	Right limb h_2	Pressure Head difference $h=h_1-h_2$	Dead Weight W_1	Spring Weight S_2	
Unit		Kg/cm^2	m of water	m	m	m	kg	kg	RPM
1	1/4								
2	1/4								
3	1/4								
4	1/4								
5	1/2								
6	1/2								
7	1/2								
8	1/2								
9	3/4								
10	3/4								
11	3/4								
12	3/4								
13	Full								
14	Full								
15	Full								
16	Full								

Calculations:

A. Discharge

1. Manometer left limb reading h_1 = …….. m.

2. Manometer right limb reading h_2 = ……..m.

3. Difference of level, h= h_1-h_2 = ...m.

4. Equivalent head of water, H_1 = 12.6 x h = …….m.

5. Area $a_1 = \pi/4 X\ d^2_1$ = …….m^2

6.Area $a_2 = \pi/4\ X\ d^2_2$ = ……....m^2

7. Discharge measured by venturimeter, Q

$Q = C_d \times a_1 a_2 \times \sqrt{2g H_{1/(a1^2 - a2^2)}}$ m^3/sec

= ……..

= ……m^3/sec

B. **Head**:

1. Pressure gauge reading, P= p x 10^4 kg/m^2 = p x 10^4 x 9.81 N/m^2

= ……N/m^2

2. Specific weight of water = w = 9810 N/m^3

Net pressure head on pelton wheel, H = P/w = …….. m of water

C**. Input to Pelton wheel P_i** = W X QX H/1000

= 9810 X QX H/1000

= ……..

= …….. KW

D**. Output of Turbine**:

1. Equivalent brake drum diameter D = ……m

2. Hanger dead weight, w_1 = ……..Kg = ……..kg x 9.81 = ……N

3. Spring load , S_2 = ……kg =……..kg x 9.81 =……N

4. Resultant load on pelton wheel, W = ($W_1 - S_2$) =……..N

5. Torque (T) on pelton wheel

= Resultant load X effective brake drum radius

= W X d/2 = …….Nm

6. Specific speed of turbine, $N_s = N \times \sqrt{P/H^{5/4}}$

= ……rpm

7. Output power from turbine, P_0 = $2\pi NT/60$ Watts

= ……Watts

8. Efficiency of turbine = p_o/p_i X 100 = …….

= …….%

XVI. Result

The result obtained on the basis of calculations

Sr. No.	Discharge (Q)	Head (H)	Input power (P_i)	Specific Speed of turbine (N_s)	Resultant Load (T)	Output power (P_0)	Efficiency (n)
	m^3/sec	M	K_W	rpm	N	K_W	%
1							
2							
3							
4							
5							
6							
7							
8							

XVII. Interpretation of Results

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XVIII. Conclusions

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the reason, the buckets are provided with notch ?
2. State how the Pelton wheel is stopped when rotation is not required.

[Space for Answer]

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XX. References / Suggestions for further reading.

1.https://youtube/isK9uMs6qf0

2.https://youtu.be/byMXJqKCl50

XXI. Assessment Scheme

Performance Indicators.		Weightage
Process Related (15 Marks)		**60%**
1.	Readings from measuring Instruments	30%
2.	Calculations of Overall efficiency	30%
Product Related (10 Marks)		**40%**
3	Interpretation of results	15%
4	Conclusions	15%
5	Practical related questions	10%
	Total (25 Marks)	**100%**

Names of Students Team Members

1……

2……

3……

4…….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 11 & 12: Dismantle and Assemble 0f Centrifugal Pump.

I Practical Significance

Centrifugal pump uses rotational kinetic energy to deliver the fluid. The rotational energy typically comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis, accelerates in the propeller and flung out to the periphery by centrifugal force

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3 **- Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency *'*Maintain hydraulic machinery using knowledge of fluid mechanics*':*

IV Relevant Course Outcome(s)

- Maintain Hydraulic Pump.

V Practical Outcome

- Dismantle a Centrifugal pump
- Assemble Centrifugal pump

VI. Relevant Affective Domain related Outcomes.

1. Maintain hydraulic joints.
2. Follow safe practices.
3. Practice energy conservation.
4. Demonstrate working as a leader/ a team member.
5. Follow ethical practices.

VII Minimum Theoretical Background

The centrifugal pump's function is as simple as its design. It is filled with liquid and the impeller is rotated. Rotation imparts energy to the liquid causing it to exit the impeller's vanes at a greater velocity than it possessed when it entered. This outward flow reduces the pressure at the impeller eye, allowing more liquid to enter. The liquid that exits the impeller is collected in the casing (volute) where its velocity is converted to pressure before it leaves the pump's discharge

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VIII Experimental setup

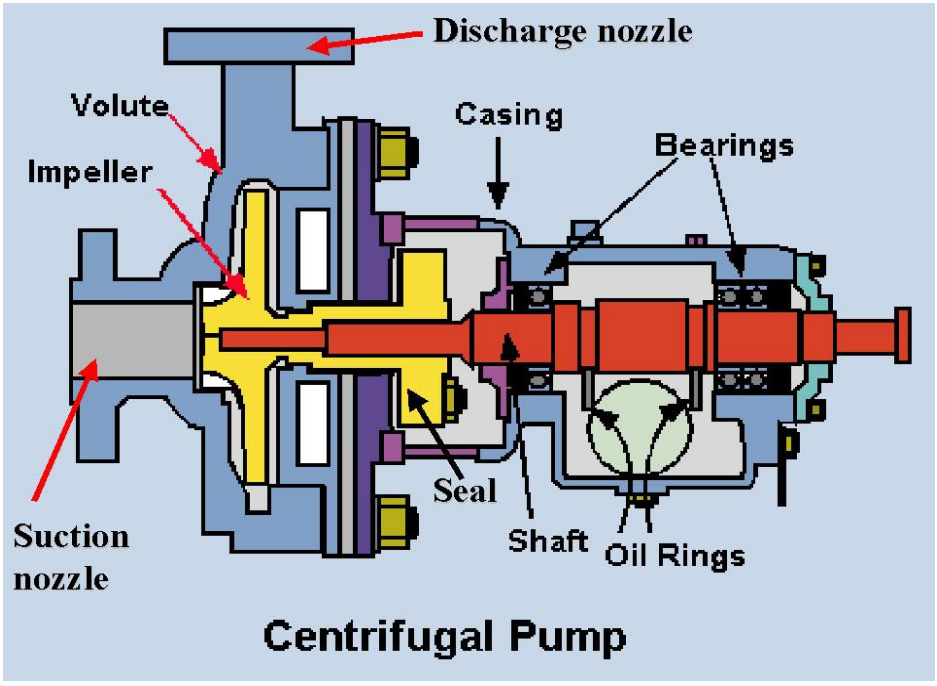

Figure 1- Schematic Diagram of Centrifugal Pump

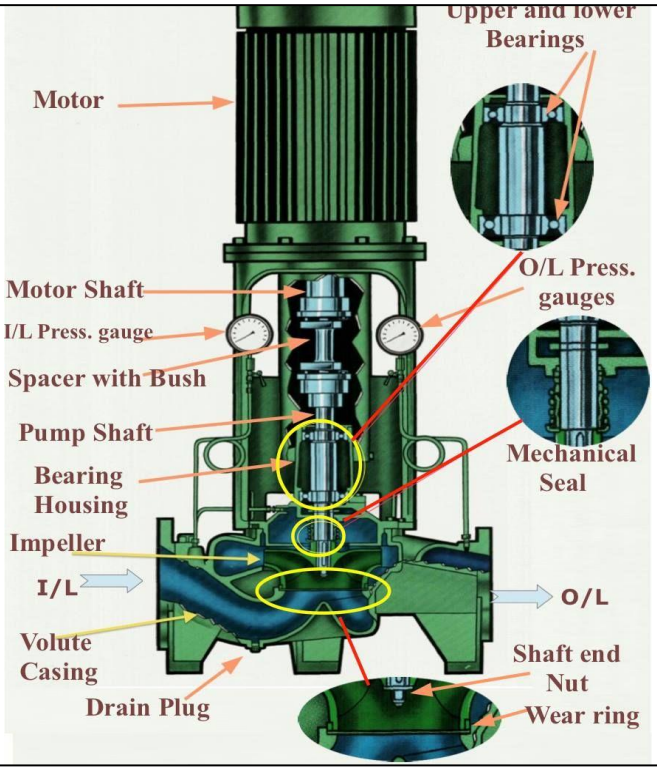

Figure 2 - Centrifugal Pump

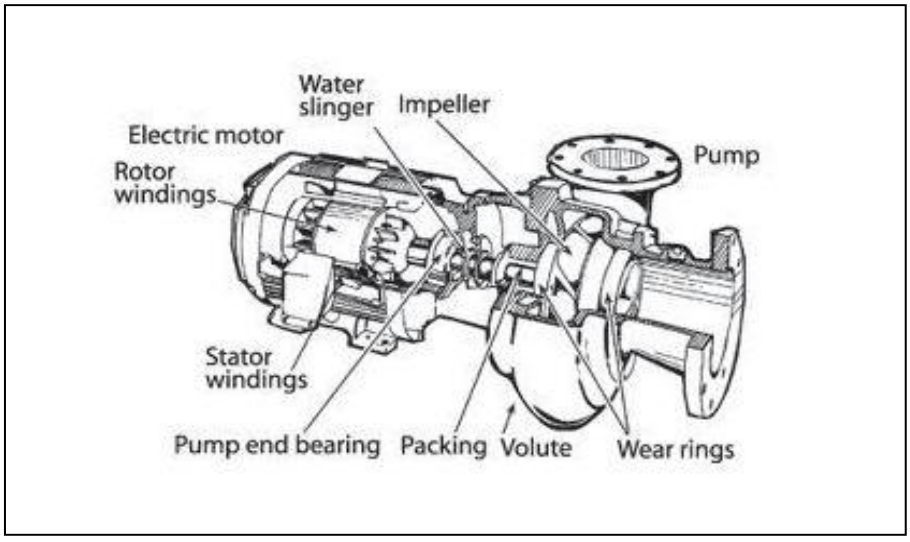

Figure 3: Internal Details of Centrifugal Pump

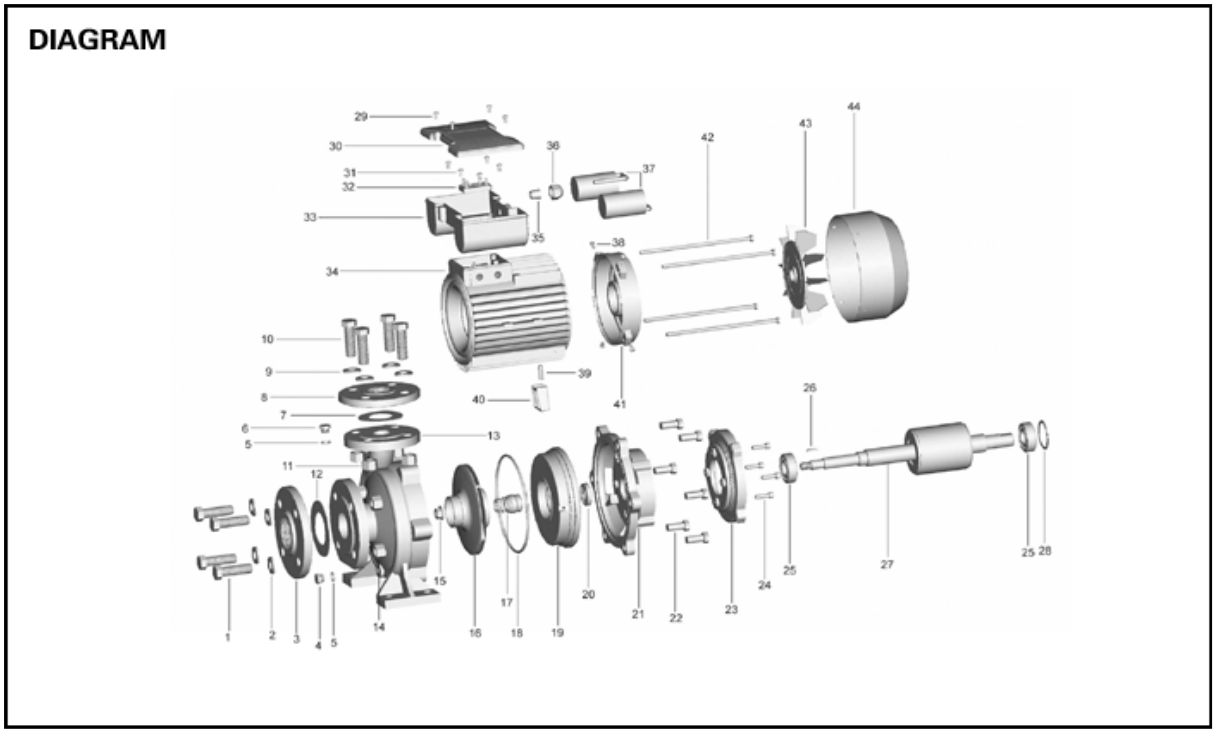

Figure 3: Sequence of Assembly of Centrifugal Pump Model 1

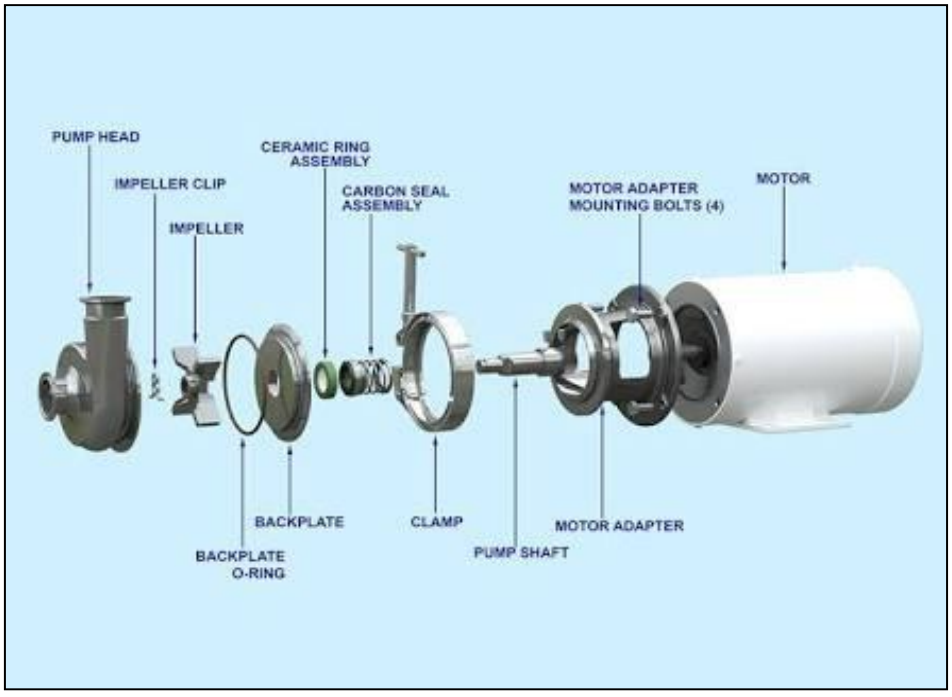

Figure 4: Sequence of Dismantling &Assembly of Centrifugal Pump Model 2

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Centrifugal Pump		1
2	Spanner Set		1 set

X Precautions to be Followed

1. Avoid improper handling of instrument.
2. Don't apply excessive pressure on fastening parts of a pump.

XI Procedure

A. Dismantling the Centrifugal Pump
   1 Drain the Pump Completely
   2 Remove coupling and make pump free from motor
   3 Remove casing with the help of spanners
   4 Remove gland packing
   5 Remove impeller from Pump shaft
   6 Observe the condition of parts.

B. Assembly of Centrifugal Pump
   1. Assemble the shaft with bearing bush
   2. Clean the shaft and remove all dirt particles
   3. Assemble impeller with given marking
   4. Assemble the housing /casing
   5. Check pump shaft to rotate freely
   6. Tighten the bolts of housing
   7. Tight bolts of coupling

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

A- Dismantling the Centrifugal Pump

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B Assembly of Centrifugal pump Pump

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XIV Precautions Followed

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XV Observations and Calculations

Sr No	Name of Part	Condition of part	Causes of Damage	Suggestive Remedies
1	**Coupling**			
2	**Pump Housing/Casing**			

3	**Impeller**			
4	**Pump Shaft**			
5	**Gland Packing**			
6	**Wear Rings**			
7	**Suction Pipe**			
8	**Delivery pipe**			

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

a. Name any five Indian Manufacturers of Hydraulic Centrifugal pumps

b. Write detail specification of Centrifugal Pump used for practical

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=sLZeR7RMGFA

XX Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the instruments	20%
2	Sequence of removing the parts	40%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. …….
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.13: Determine overall efficiency of Centrifugal Pump

I. Practical Significance

A Pump is generally used to induce flow or raise the pressure of a liquid. Centrifugal pumps are a category of Dynamic pumps. The working principle of centrifugal pumps involves imparting energy to the liquid by means of a centrifugal force developed by the rotation of an impeller that has several blades or vanes.

II. Relevant Program Outcomes (Pos)

PO1- Basic Knowledge: Apply knowledge to measure Pressure gauge reading at Suction pipe and delivery pipe of the Centrifugal pump. Measure Pressure Head at inlet and Pressure Head at outlet of Centrifugal pump. Measure rise in water level in measuring tank and note the time required for water being collected.

PO3- Experiments and practice: Plan to perform experiments and practices to use the results to measure Input power , discharge , Manometric head (Hm) and output power of centrifugal pump to Calculate the Overall efficiency of Centrifugal pump.

III Competency and Skills:

This practical is expected to develop the following skills for the industry identified competency *'*Maintain hydraulic machinery using knowledge of fluid mechanics*':*

Maintain hydraulic machinery using knowledge of fluid mechanics.

1. Ability to prime the Centrifugal pump.
2. Ability to measure Pressure gauge reading at Suction pipe and delivery pipe of the Centrifugal pump

1V. Relevant Course Outcome(s)

- Maintain Hydraulic Pump.

V. Practical Outcome.

- Determine overall efficiency of Centrifugal Pump and plot its operating characteristics using Centrifugal pump test rig

VI. Relevant Affective Domain related Outcomes.

1. Maintain pressure gauges, electronic energy meter, stop watch in good condition.
2. Follow safe practices.
3. Practice energy conservation.
4. Demonstrate working as a leader/ a team member.
5. Follow ethical practices.

VII. Minimum Theoretical Background.

Centrifugal pump efficiency is the ratio of Hydraulic power delivered by the pump to the brake horsepower supplied to the pump

VIII. Experimental setup.

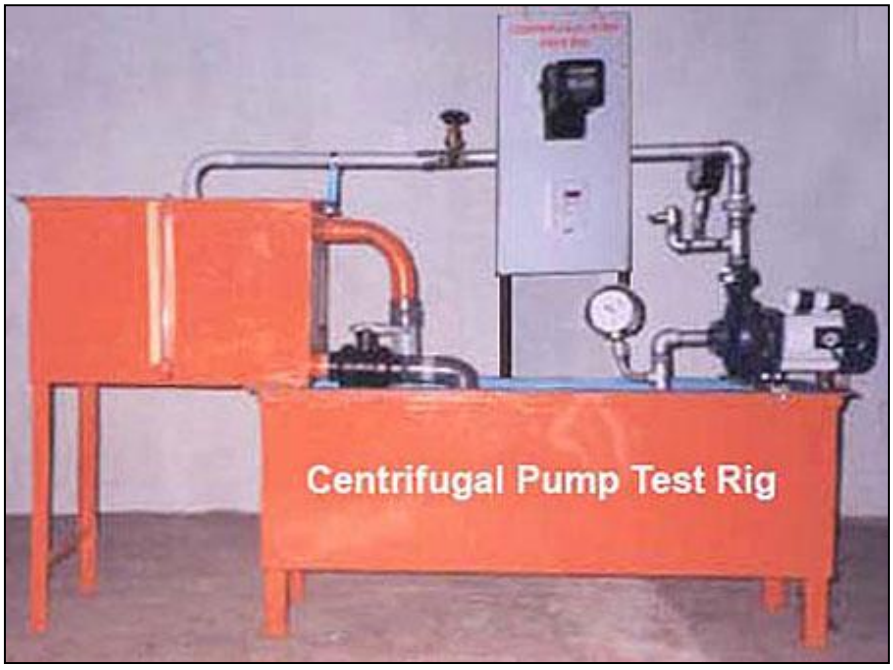

Figure 1: Centrifugal Pump test rig

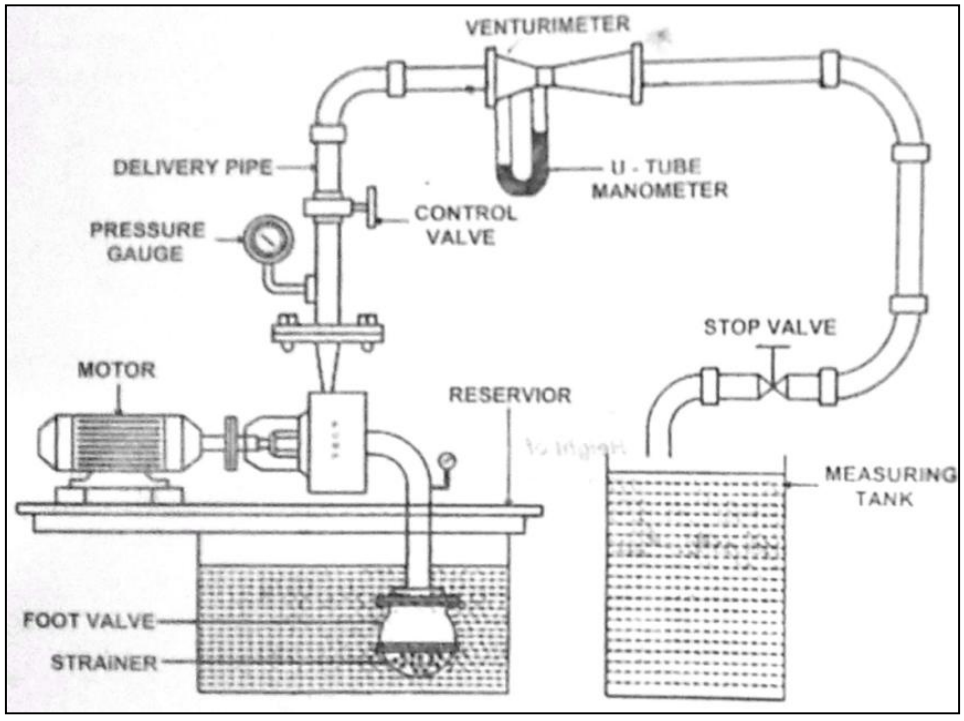

Figure.2 Experimental set up for determination of overall efficiency of Centrifugal Pump

IX. Resources required.

S.No.	Name of Resource	Specifications	Quantity
1.	Centrifugal Pump test rig. test rig consists of, 1. Centrifugal pump with motor. 2. Measuring tank. 3. Electronic energy meter. 4. Suction and delivery valves. 5. U tube Manometer 6. Suitable arrangement of water supply and storage.	Vacuum Gauge Bourdon type, Range: 0-760 mm of Hg Stop Watch Electronic Measuring Tank Material Stainless Steel Sump Tank Material Stainless Steel Electricity supply Single Phase, 220 VAC, 50 Hz, 5-15 Amp Clear Water Flow Medium Pump Type Centrifugal ,2800 RPM Driven Speed Variable Pressure Gauge Bourdon Type, Range0-4 kg/cm2 Compound Gauge Bourdon type, Range: -760 mm of Hg to 2 kg/cm2	01
3	Stopwatch.	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	01

X Precautions to be Followed

1. The delivery valve should be kept completely open while priming operation of Centrifugal pump.
2. Count the no of blinks occurring per minute in the electronic energy meter perfectly.

XI. Procedure

1. Check the experimental set up carefully.
2. Ensure that the delivery valve is completely open for the priming of pump by filling liquid/water so as to remove entrapped air by operating the key present on casing.
3. Switch ‘ON’ the pump .
4. Collect the discharge of liquid in a measuring tank and measure rise of water level after T seconds
5. Note the delivery and suction pressure .
6. Note no of blinks per minute of electronic energy meter.
7. Note down the reading of manometer connected to Venturimeter
8. Note 3-4 sets of reading.
9. Plot the graphs on single graph paper.
   - Discharge Vs Head.
   - Discharge Vs Power
   - Discharge Vs Overall efficiency.

   (Note: Take discharge Q on X-axis)

XII. Resources Used.

S.No	Name of Resource	Broad Specifications		Qty	Remarks (if any)
		Make	Details		
1.					
2					
3					

XIII. Actual Procedure Followed.

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XIV. Precautions Followed

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XV. Observations and Calculations

1. Cross sectional area of rectangular measuring tank
   A = L X B = …… m^2

2. Efficiency of electric motor used = …….
   (Assume it 90% if, not indicated on motor)
   Electronic energy meter constant (EMC) K = imp/Kwh
   (1 Kwh. = 3600KJ)
3. Take mass density of water = 1000 Kg/m^3

Sr. No	Suction Pressure (P_1)	Pressure Head at inlet $H_1=p_1/w$ (-ve for vacuum)	Delivery Pressure (P_2)	Pressure Head at outlet $H_2=p_2/w$	Rise in water level in tank H	Time of water collection in tank T	No of Blinks per minute (n)
	Kg/cm^2	**$=P_1$x 10m**	**Kg/cm^2**	**$=P_1$x 10m**	**M**	**Seconds**	
1.							
2.							
3.							
4.							
5.							
6.							

The input power to the pump.

Input power = Energy supplied in KJ/sec x efficiency of electric motor.

= n x 3600/ (60 x K)

Volume of water collected in measuring tank. V

V = cross section area of tank x Rise in level of water in tank

V =A X H = …….

= …….. m^3

Discharge (Q) = (Volume of water collected)/ (Time of water collection)

= V/ T

= ……/…… (Insert values)

Q = ……. m^3/sec.

Manometric Head = (H_m)

H_m= Pressure head at outlet of pump - Pressure head at outlet of pump

$H_m = H_2 – (- H_1)$

$H_m = H_2 - H_1$ (insert value)

H_m= …… m

The output power from the pump.

O/P power = w XQ X $H_{m/1000}$

= .....

= …….Kw

Overall efficiency of Centrifugal pump = Output power/ Input power

= ……..

XVI. Result

The result obtained on the basis of calculations

Sr.No	I/P Power	Discharge Q	Manometric Head H_m	O/P power	Overall efficiency
	Kw	m^3/sec	M	Kw	(ɧo)%
1.					
2.					
3.					
4.					
5.					
6.					


Scale
X-axis -
Y-axis -

XVII. Interpretation of Results

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XVIII. Conclusions

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List the effect of leakages in suction pipe ?
2. State the reason, Length of suction pipe is always less than delivery pipe?

[Space for Answer]

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XXI References / Suggestions for further reading.

1. https://youtu.be/oLUjy8Iyfbk
2. https://youtu.be/BaEHVpKc-1Q4.

XXII Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	30%
2	Calculation of final readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.14 & 15: Dismantle and Assemble 0f Reciprocating Pump.

I Practical Significance

Reciprocating pump is a positive plunger pump. They are used widely in lifting water from ground to the storage tanks in residential areas. They develop high pressures but has limited use. Reciprocating pump consists of "suction stroke" and a "delivery stroke". Suction stroke is the place where the water is sucked in from the ground and delivery stroke is the place where the sucked water is delivered to the required place.

II Relevant Program Outcomes (POs)

PO1- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

This practical is expected to develop the following skills for the industry identified competency *'*Maintain hydraulic machinery using knowledge of fluid mechanics*':*

IV Relevant Course Outcome(s)

- Maintain Hydraulic Pump.

V Practical Outcome

- Dismantle a Reciprocating pump

VI. Relevant Affective Domain related Outcomes.

1. Maintain pressure gauges, electronic energy meter, stop watch in good condition.
2. Follow safe practices.
3. Practice energy conservation.
4. Demonstrate working as a leader/ a team member.
5. Follow ethical practices.

VII Minimum Theoretical Background

Reciprocating pump operates on the principle of pushing of liquid by a piston that executes a reciprocating motion in a closed fitting cylinder.

Components of reciprocating pumps:-

a) Piston or plunger: – a piston or plunger that reciprocates in a closely fitted cylinder.

b) Crank and Connecting rod: – crank and connecting rod mechanism operated by a power source. Power source gives rotary motion to crank. With the help of connecting rod we translate reciprocating motion to piston in the cylinder.

c) Suction pipe: – one end of suction pipe remains dip in the liquid and other end attached to the inlet of the cylinder.

d) Delivery pipe: – one end of delivery pipe attached with delivery part and other end at discharge point.

e) Suction and Delivery value: – suction and delivery values are provided at the suction end and delivery end respectively. These values are non-return values.

VIII Experimental setup

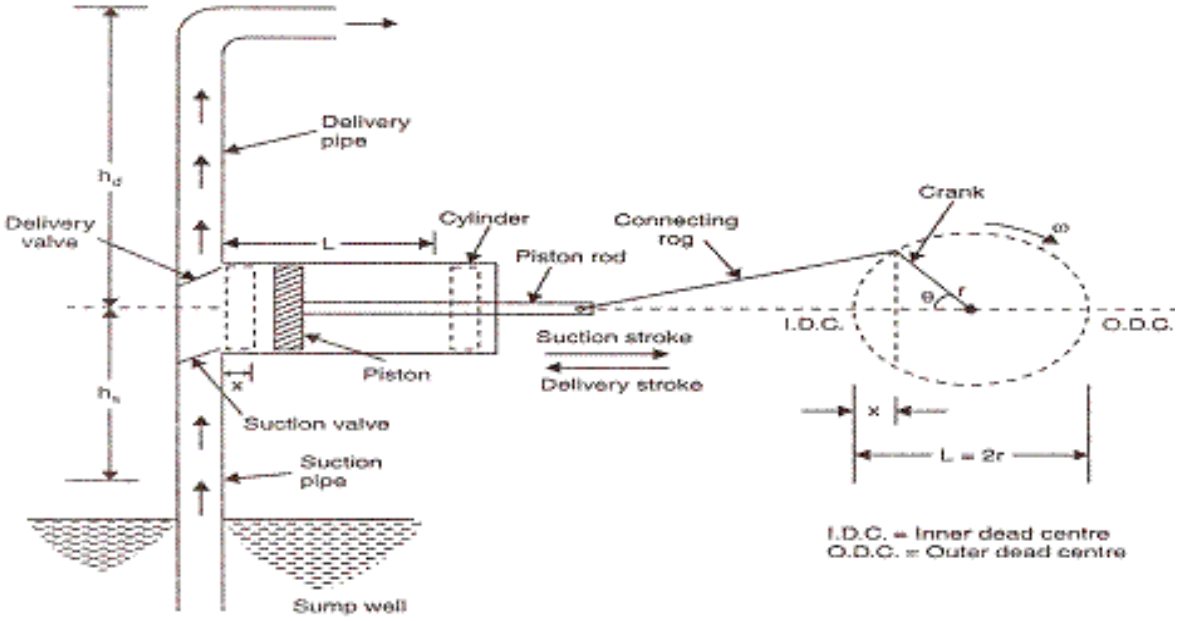

Figure No 1- Layout of reciprocating Pump

Figure No 2- Reciprocating Pump

Figure No 3 – Parts of Reciprocating Pump

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Single Acting Reciprocating Pump		1
2	Spanner Set		1 set

X Precautions to be Followed

1. Avoid improper handling of instrument.
2. Don't apply excessive pressure on fastening parts of a pump.

XI Procedure

A. Dismantling the Reciprocating Pump

a. Loose packing nuts of suction pipe
b. Remove suction Pipe
c. Loose packing nuts of delivery pipe
d. Remove Delivery Pipe
e. Remove the casing of a pump
f. Remove packaging seal from the pump
g. Loose the valve pin
h. Remove valves from pump
i. Remove upper piston guide
j. Unthread piston bar
k. Remove bearing between piston and connecting rod
l. Remove Bearing between Connecting rod and crank
m. Observe the conditions of each part
n. Note down the condition of each dismantled part.

B. Assembly of Reciprocating Pump

1. Assemble and connecting rod
2. Check the condition of bearing
3. Assemble piston and connecting rod

4. Place piston and piston assembly in a cylinder.
5. Replace new packing seal
6. Assemble valve in valve plates
7. Fix valve plate to the cylinder using packing nuts
8. Connect suction pipe to the suction passage with the help of nuts
9. Connect delivery pipe to the delivery passage with the help of nuts.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

A- Dismantling the Reciprocating Pump

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B Assembly of Reciprocating Pump

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XIV Precautions Followed

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XV Observations and Calculations

Sr No	Name of Part	Condition of part	Causes of Damage	Suggestive Remedies
1	Casing			

2	Piston/Plunger			
3	Connecting Rod			
4	Bearing			
5	Bushings			
6	Crank			
7	Suction Pipe			
8	Delivery Pipe			

9	Suction Valve			
10	Delivery valve			
11	Packaging Seals			

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

a. Name any five applications of Hydraulic reciprocating pumps
b. Write detail specification of Reciprocating Pump used for practical

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=sLZeR7RMGFA

XXI Assessment Scheme

Performance Indicators		Weight age
Process Related (15 Marks)		**(60%)**
1	Handling of the instruments	20%
2	Sequence of removing the parts	40%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.16 & 17: Determine Overall Efficiency and Percent Slip Of Reciprocating Pump

I Practical Significance

Reciprocating pump is a positive plunger pump. They are used widely in lifting water from ground to the storage tanks in residential areas. They develop high pressures but has limited use. Reciprocating pump consists of "suction stroke" and a "delivery stroke". Suction stroke is the place where the water is sucked in from the ground and delivery stroke is the place where the sucked water is delivered to the required place

II Relevant Program Outcomes (PO s)

PO1- Basic Knowledge: Apply knowledge of operating Single /Double acting reciprocating pump, to measure pressure at Suction and delivery of the reciprocating pump, pressure head , and speed of shaft with the help of tachometer.

PO3- Experiments and practice: Plan to perform experiments and practices to use the results to solve actual and theoretical discharge of reciprocating pump, time required for electric meter disc for calculation of input power and calculate the Overall efficiency of reciprocating pump.

III Competency and Skills:

This practical is expected to develop the following skills for the industry identified competency *'*Maintain hydraulic machinery using knowledge of fluid mechanics*':*

1. Operate the Single /Double acting reciprocating pump.
2. Measure Pressure at Suction and delivery of the reciprocating pump.
3. Measure rpm of the shaft with the help of tachometer.
4 Measure actual and theoretical discharge of reciprocating pump.

1V. Relevant Course Outcome(s)

- Maintain Hydraulic Pump

V. Practical Outcome.

- Determine overall efficiency of Reciprocating pump using Reciprocating pump test rig
- Determine percent slip of Reciprocating pump..

VI. Relevant Affective Domain related Outcomes.

1. Follow safe practices.
2. Practice energy conservation.

VII. Minimum Theoretical Background.

(1) Reciprocating pumps draw liquid into a cylinder by the action of a piston, a plunger or a diaphragm; the liquid is then discharged in the required direction by the use of check valves.

(ii) Coefficient of Discharge: The ratio between the actual discharge and theoretical discharge is known as coefficient of discharge.

$$Cd = Qact / Qthe.$$

(iii) Slip in reciprocating pump is the measure of difference between theoretical discharge and actual discharge.

Slip = Qth – Qact

When actual discharge delivered by reciprocating pump is less then theoretical discharge then that difference is called as **Positive Slip**. Actual discharge becomes less than theoretical discharge due to leakages while operation. And when actual discharge delivered by reciprocating pump is more than theoretical discharge then that difference is called as **Negative Slip.**

VIII. Experimental setup.

Fig. 1 Reciprocating pump test rig

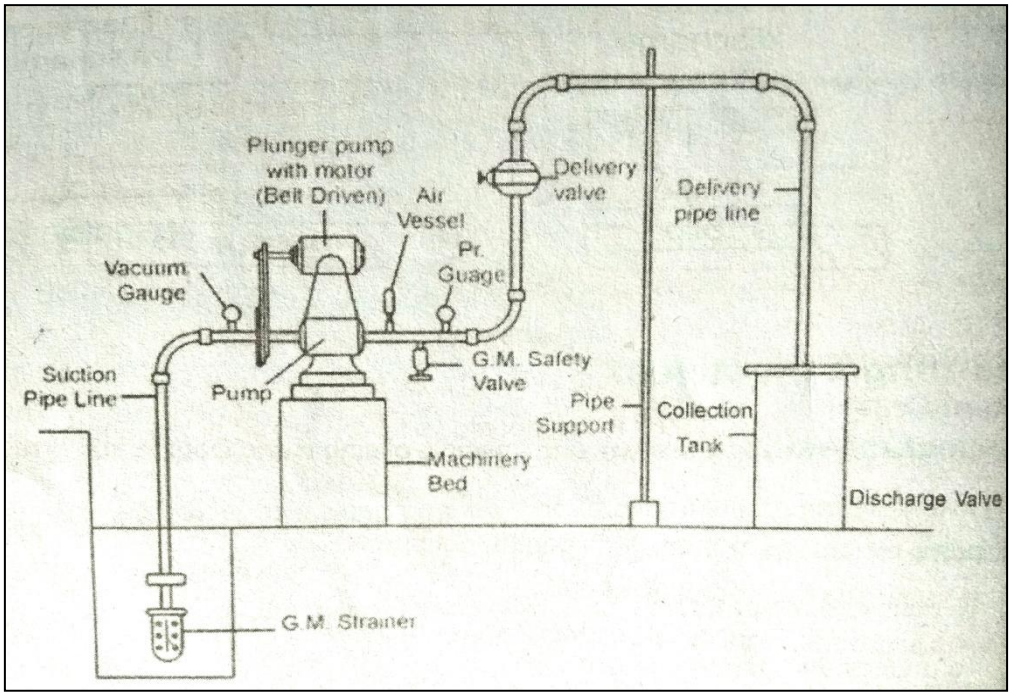

Fig.2 Experimental set up of reciprocating pump test rig.

IX. Resources required.

S.No.	Name of Resource	Specifications	Quantity
1.	Reciprocating pump test rig. test rig consists of, 1. Reciprocating pump. 2. Measuring tank. 3. Energy meter. 4. Suction and delivery valves. 5. Suitable arrangement of water supply and storage.	Reciprocating Pump – 1H.P (700 RPM) • D.C. Motor – 1HP (1500 RPM) • Sump tank - 1200 x 400 x 395 mm. • Measuring tank - 330 x 400 x 395 mm. • Energy meter for motor input measurement.• Transparent pizometer tube with scale to measure measuring tank discharge.	01
2.	Tachometer	RPM Ranges 10-10,000 rpm, Accuracy ±0.5% Full Scale	01

3	Pressure gauge	• Pressure & Vacuum gauge for measurement of head.	01
4	Stopwatch.	Timing capacity:23hrs, 59mins and 59.99secs,Accuracy: ±3 seconds/day	01

X. Precautions to be Followed

1. Avoid parallax while taking the pressure gauge points (Z_1 and Z_2)
2. Tachometer should be placed perfectly perpendicularly while taking the reading.

XI. Procedure

1. Measure the distance between the gauges i.e. difference between potential heads (ΔZ)
2. Note the diameters of suction and delivery pipes D_1 and D_2
3. Note the step of the core pulley on which the belt is mounted.
4. Start the pump.
5. Note the time required for 10 revolution of electric Energymeter disc.
6. Close the discharge valve of the collecting tank,
7. Note time required to rise in height of water level (say 10 cms)
8. Note the suction and delivery pressures.
9. Switch off the motor.
10. Shift the belt in other step of cone pulley.
11. Repeat steps 6 to 9 again.
12. Follow similar procedure for remaining two steps.

XII. Resources Used.

S. No	Name of Resource	Broad Specifications		Qty	Remarks (if any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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.....
.....

XV Observations and Calculations

Suction pipe diameter, D_1 = **……**m

C/S Area of suction pipe, As = $\pi/4\ D_1^{\ 2}$ =…….

Delivery pipe diameter, D_2 = **……**m

C/S Area of Delivery pipe, $A_d = \pi/4\ D_2^{\ 2}$ =…….m^2

Difference between heights of pressure gauge points i.e. Z_1 and Z_2 from datum.

$Z_2 - Z_1 = Z$ = … …… m

Diameter of cylinder bore, D = ……. m

Length of stroke, L = ……. m

Area of measuring container, A = …….. m^2

Take transmission efficiency: h_t = 60% = 0.6 (if not mentioned in the instructional /operational manual of Reciprocating pump test rig)

Electric motor efficiency : h_e = 70% = 0.7

Constant of electric energy meter = …

Sr. No	Suction Pressure(P_1)		Delivery Pressure(P_2)		Time for 20 revolution of disc of energy meter (Sec)	Time for 10 cm rise in height of water level in contained (Sec)	RPM of the crank shaft
	Kg/cm^2	m. of water h_s	Kg/cm^2	m. of water h_d	(5)	(6)	(7)
	(1)	(2) = 10x(1)	(3)	(4)= 1X(3)			
1.							
2.							
3.							
4.							
5.							
6.							

Formulae for calculations:

For reading No:……

Input power = Number of disc revolution x 3600 sec x h_t x h_e x 1000 / (Constant of electric meter x time required for number of revolution of disc)

= …….

= ……. Watts.

Q th = 2x π/4 x D^2xL x N/ 60 m^3/sec (For double acting pump)

= ……..

= ……

Q_{act} = [Area of measuring container x rise in water level] / Time required for rise

= …… m^3/sec

Sp. Weight of water w = 9810 N/m^3

Output power = w x Q x ($h_s + h_d + Z$) Watts.

= ……

= …… Watts.

Theoretical Discharge: Q_{th}= ALN/60 (single acting)

Theoretical Discharge: Q_{th}= 2ALN/60 (Double acting)

Where, A= cross section of piston = $\frac{\pi}{4} x D^2$

D= Diameter of cylinder

L= Length of stroke= 2 x r

r= Radius of Crank

N= RPM of crank

Coefficient of discharge, C_d = Actual discharge / Theoretical discharge

= Q_{act}/ Q_{th}

= ……..

Slip = ($Q_{th} - Q_{act}$) = ……

% Slip = [($Q_{th} - Q_{act}$) / Q_{th}] x 100

= [1- Qact/Qth)] x 100

= (1-Cd) x 100,

Where Cd= Coefficient of Discharge= Qact/Qth

=

Efficiency = output power/ Input power

= ……

XVI. Result

Sr. No	Input Power (Watts) (1)	Output Power (Watts) (2)	Efficiency (2)/(1)	Average Efficiency
1				
2				
3				
4				
5				
6				

XVII. Interpretation of Results

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XVIII. Conclusions

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XIX. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Reciprocating pump is a positive displacement pump? State the reason
2. List different methods of getting continues discharge from reciprocating pump?

[Space for Answer]

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XX References / Suggestions for further reading.

1. https://www.youtube.com/watch?v=h4LSj59gC2k
2. https://www.youtube.com/watch?v=uIsXXewKz1c
3. https://www.youtube.com/watch?v=nM-Vmgo_ZxM
4. www.youtube.com/watch?v=FmQjDQ4q2ww

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the measuring Instruments	40%
2	Calculation of final readings	20%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	20%
4	Conclusions	10%
5	Practical related questions	10%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……..
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics Engineering	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	C Language programming	22218
15	Basic Electronics	22225
16	Programming in C	22226
17	Fundamental of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemical	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurement	22420
12	Digital Electronic And Microcontroller Application	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Micro Project & Industrial Training Assessment Manual	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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