INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

HYDRAULICS AND HYDRAULIC MACHINERY LABORATORY								
IV Semester: CE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ACEE16	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	2	1	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite:								

I. COURSE OVERVIEW:

The Fluid mechanics and Hydraulic Machinery Laboratory course is an indispensable supplement to theoretical knowledge. The course delves into the intricacies of fluid dynamics, offering a comprehensive study of hydraulic systems, theoretical principles and practical applications. It engages in in-depth analyses of hydraulic components, pumps, valves, and actuators, enhancing their proficiency in the design and optimization of hydraulic machinery. This course will focus on the behaviour of fluid under various conditions, providing hands-on experience in the fluid mechanics laboratory to explore principles such as flow dynamics, viscosity.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental knowledge of fluid properties and behavior under static and dynamic conditions of closed conduit and open channels.
II. The operating principle of various turbo machinery and analyze their performance characteristics under various operating conditions.
III. Vital principles of traffic studies and to implement traffic regulation and control measures.
IV. The measurement of flow rate through various internal and external fluid flow systems

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO1 Outline the concept of calibrating orifice and venturi meter to minimize uncertainty in the discharge coefficient.
CO2 Analyze the basic concepts of flow through the pipes and their losses for determining fluid pressure and head.
CO3 Measure the discharge through various notches to determine the flow of fluids in different hydraulic structures.
CO4 Examine the flow patterns in different flow conditions for determining the velocities, pressures and acceleration in a moving liquid.
CO5 Interpret the law of conservation of energy, Bernoulli's theorem for estimating total energy of various geometrical cross-section of a pipe.
CO6 Compare the performance characteristics of various turbines in different operating conditions for enhancing efficiency and output under specific applications.

IV. COURSE CONTENT:

EXCERCISES ON HYDRAULICS AND HYDRAULIC MACHINERY LABORATORY

Getting Started Exercises

1. Introduction to laboratory

The Hydraulics and Hydraulic Machines Laboratory is a fundamental space within the realm of engineering education, providing students with hands-on experience and practical insights into the principles governing fluid behaviour and hydraulic machinery. This laboratory is specifically designed to complement theoretical knowledge with real-world experiments, fostering a deeper understanding of fluid mechanics concepts and hydraulic system dynamics. The primary objective of the Hydraulics and Hydraulic Machinery Laboratory is to impart a comprehensive understanding of fluid mechanics concepts and the functioning of hydraulic machinery.

2. BERNOULLI'S APPARATUS FOR HORIZONTAL PIPES

Bernoulli's equation in fluid mechanics relates fluid pressure, velocity, and gravitational potential energy, serving as a foundational tool for analysing fluid flow behaviours in engineering applications. The testing apparatus is illustrated in Fig. 3.1.

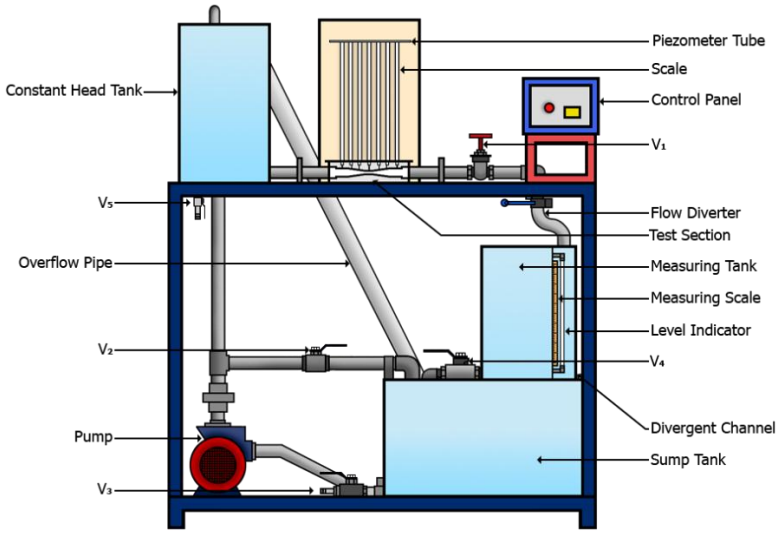

Fig. 3.1: Bernoulli's equation

Try: What is the overall influence of fluid dynamics on the application of Bernoulli's equation in engineering and fluid control practices

1. How do variations in fluid velocity affect the application and accuracy of Bernoulli's equation?
2. What mechanisms elucidate the relationship between fluid properties and the precision of Bernoulli's equation in predicting pressure and velocity changes?

3. BERNOULLI'S APPARATUS FOR INCLINED PIPES

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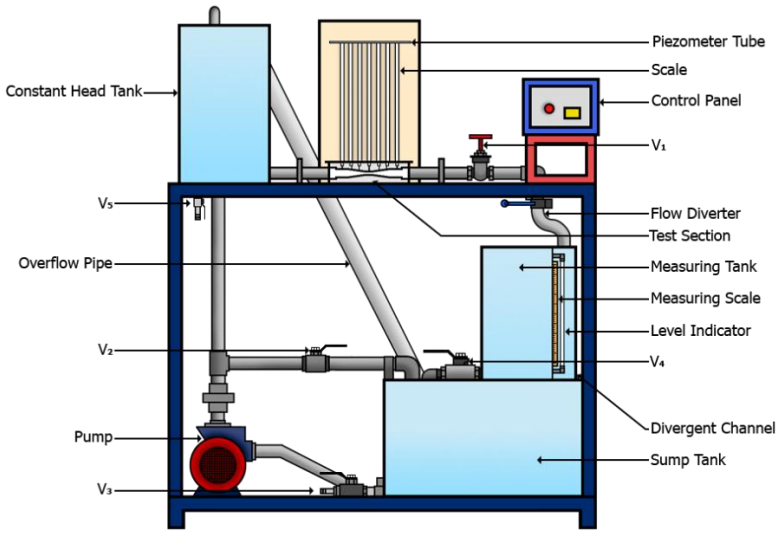

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4. IMPACT OF JET ON FLAT VANES

The study of the impact of a jet on vanes, encompassing both flat and curved configurations, delves into the fundamental principles governing fluid-solid interactions. Stationary surfaces like flat as shown in Fig. 7.1.

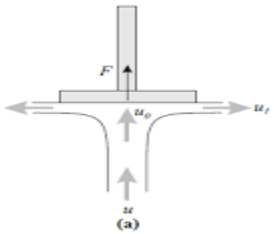


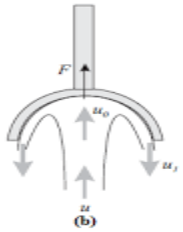
Fig. 7.1 Impact of Jet on flat vanes

Try: How does the orientation of a flat and curved vane impact the resultant forces and deflections when subjected to a high-velocity water jet?

1. How does the design of flat vanes differ from curved vanes in terms of their response to the impact of a high-velocity jet?
2. In the context of the impact of a jet on vanes, what role do principles of impulse and reaction play?

5. IMPACT OF JET ON CURVED VANES

The study of the impact of a jet on vanes, encompassing both flat and curved configurations, delves into the fundamental principles governing fluid-solid interactions. Stationary surfaces like curved vanes as shown in Fig. 7.1.



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6. FLOW THROUGH TRIANGULAR NOTCH

Triangular notches represent key hydraulic structures employed for flow measurement in open channels. Types of notches are shown in below Fig. 6

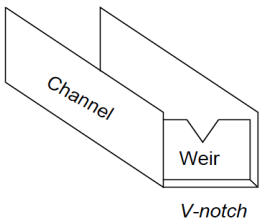


Fig 4: Types of notches in a channel

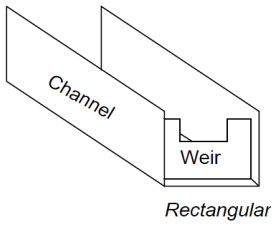
1. Employing trapezoidal configurations, notches play a crucial role in hydraulic engineering, facilitating accurate assessments of water discharge.
2. The diverse shapes of notches serve as versatile tools, aiding engineers in quantifying flow rates and making informed decisions in water resource management.

Try: How can engineers leverage notch measurements to enhance the efficiency of water management systems?

1. How does the shape and dimensions of a notch impact its discharge coefficient for accurate flow rate measurements?
2. In what ways do notches contribute to the design and optimization of hydraulic infrastructure?
3. How can the precise measurement of flow rates through notches aid in sustainable decision-making for agricultural, industrial, and environmental applications?

7. FLOW THROUGH RECTANGULAR NOTCH

Rectangular notches represent key hydraulic structures employed for flow measurement in open channels. Types of notches are shown in below Fig. 6



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8. FLOW THROUGH TRAPEZIODAL NOTCH

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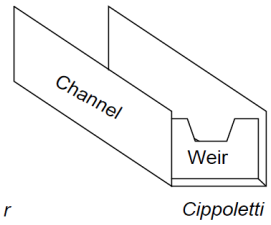

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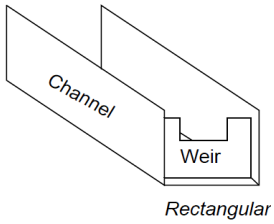

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10. EFFICIENCY OF PELTON WHEEL TURBINE

The Pelton wheel turbine is a high-head hydropower technology designed to harness the kinetic energy of water. Its iconic spoon-shaped buckets efficiently capture energy from high-velocity jets. The Pelton wheel consists of a runner with double-bucket cups, a spear-like nozzle to direct water jets, and a shaft connected to an electric generator. The primary aim of the Pelton wheel is to convert the kinetic energy of water at high heads into mechanical power, generating efficient and sustainable electricity in mountainous regions. The testing apparatus are shown in fig. 8.1.

1. Investigating how variations in water head impact the efficiency and power output of Pelton wheel turbines.
2. Examining different Pelton wheel designs and their impact on energy extraction.
3. Assessing the potential effects of soil settlement due to vibratory compaction on the foundations supporting Pelton wheel turbines.

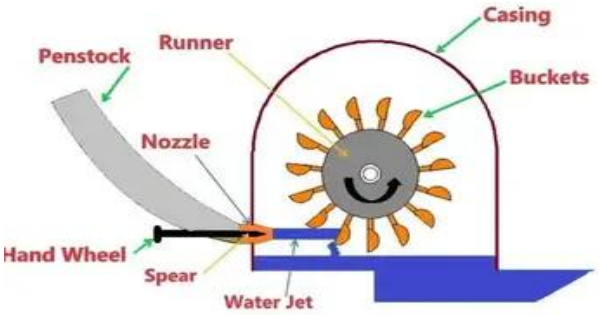

Fig. 8.1: Pelton wheel turbine apparatus.

Try: How does the choice of turbine design, such as Pelton wheel impact the overall efficiency and adaptability of hydropower systems, considering varying water heads and geotechnical conditions?

1. How does varying water head affect the performance and efficiency of Pelton wheel turbines, and what design modifications can enhance their adaptability to changing hydraulic conditions?
2. What are the key factors influencing the comparative efficiency of different Pelton wheel designs, and how can engineers optimize configurations for maximum energy extraction in high-head hydropower projects?
3. In what ways does soil settlement due to vibratory compaction impact the stability of Pelton wheel turbine foundations, and what geotechnical considerations are crucial for their long-term operation in diverse terrains?

11. POWER GENERATION OF PELTON WHEEL TURBINE

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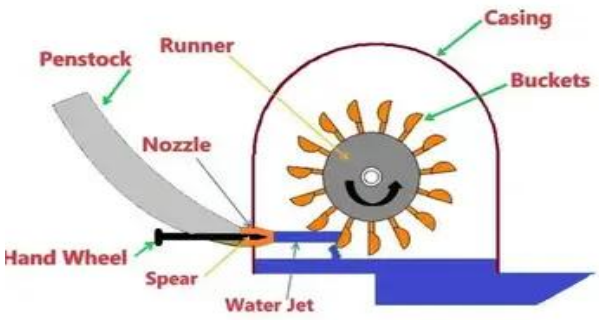

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12. PERFORMANCE OF SINGLE STAGE CENTRIFUGAL PUMP

The single-stage centrifugal pump is a versatile fluid transport device designed for applications requiring moderate pressure and flow rates. It operates on the principle of centrifugal force, propelling fluid outward from the impeller to meet specific performance criteria. Comprising a single impeller, a casing, and an inlet, the single-stage centrifugal pump is a compact design suitable for tasks such as water circulation, irrigation, and heating systems. The primary aim is to efficiently move fluid by converting rotational energy into kinetic energy, providing reliable and continuous operation in applications requiring modest pressure and flow. The testing apparatus are shown in fig. 10.1.

1. Investigating the initial fluid content affects the efficiency of single stage centrifugal pump systems, particularly in moving liquids from one location to another.
2. Conducting a comparative analysis of single stage centrifugal pump systems to assess their performance across various fluid types.
3. Exploring how the duration of pump operation influences its behavior and effectiveness in fluid transport.

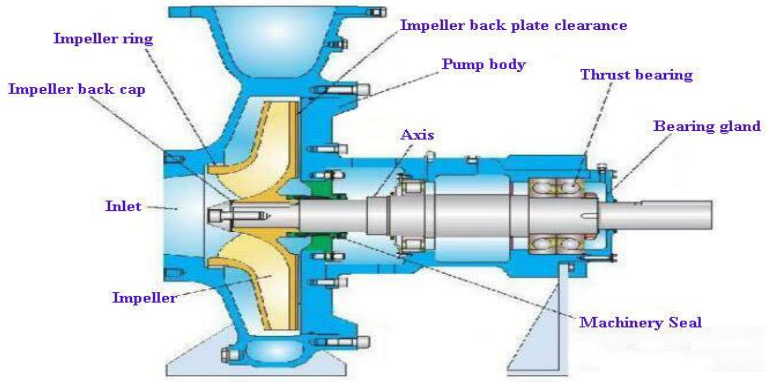

Fig.8: Single stage reciprocating pump

Try: how can its design be adapted to cater to a wide range of fluid transport applications requiring moderate pressure and flow rates?

1. How does the design of a single-stage centrifugal pump impact its efficiency in handling moderate pressure and flow applications?
2. In what ways does the single-stage centrifugal pump excel in converting rotational energy into kinetic energy
3. What considerations should be taken into account when selecting a single-stage centrifugal pump for applications requiring moderate pressure?

13. PERFORMANCE OF MULTISTAGE CENTRIFUGAL PUMP

The multistage centrifugal pump is a powerful fluid transport system designed for applications demanding high pressure and elevated flow rates. It incorporates multiple impellers in series to generate increased head and meet diverse industrial requirements. Featuring multiple impellers within a single casing, the multistage centrifugal pump is constructed with inlet and outlet ports, providing the capability to handle demanding fluid transport scenarios. The primary aim is to achieve higher pressure and flow rates by sequentially increasing the energy imparted to the fluid. This design is well-suited for industrial processes, water supply, and other applications requiring substantial hydraulic power. The testing apparatus are shown in fig. 9.

1. Investigating the initial fluid content affects the efficiency of pump systems, particularly in moving liquids from one location to another.
2. Conducting a comparative analysis of pump systems to assess their performance across various fluid types.
3. Exploring how the duration of multistage centrifugal pump operation influences its behavior and effectiveness in fluid transport.

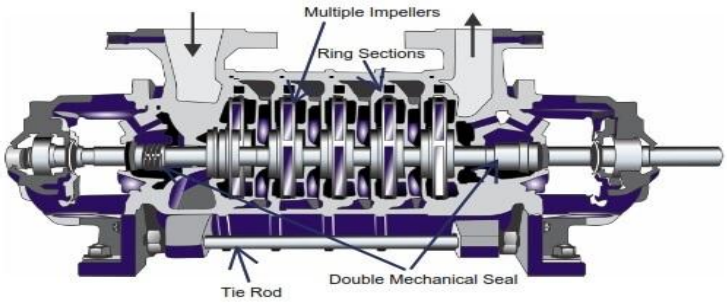

Fig. 9: Multistage centrifugal pump apparatus.

Try: How does the sequential energy impartation in a multistage centrifugal pump contribute to its ability to generate high pressure and handle substantial flow rates, and what industries benefit most from this design feature?

1. How does the sequential energy impartation in a multistage centrifugal pump contribute to its ability to generate high pressure?
2. What challenges do multistage centrifugal pumps address in industrial fluid transport?
3. What specific features make it a preferred choice for fluid transport in complex scenarios that demand both high pressure and substantial flow rates?

14. PERFORMANCE ON SINGLE ACTING RECIPROCATING PUMP

The single-acting reciprocating pump is a mechanical fluid displacement device designed for applications requiring intermittent and moderate fluid flow. Operating on a piston-cylinder mechanism, it provides unidirectional flow by utilizing reciprocating motion. Comprising a cylinder, piston, suction and discharge valves, and a power source, the single-acting reciprocating pump ensures unidirectional fluid transfer, making it suitable for various industries with specific flow rate requirements. The primary aim is to deliver reliable and controlled fluid flow in applications such as water supply, small-scale irrigation, and hydraulic systems, where intermittent pumping and moderate pressures are essential.

1. Investigating how variations in initial fluid content influence the efficiency of single-acting reciprocating pumps, especially in applications involving the intermittent movement of liquids.
2. comparative study to evaluate the performance of single-acting reciprocating pumps across diverse fluid types, providing insights into their versatility and effectiveness in handling various liquid media.
3. Investigating how the duration of operation impacts the behavior and effectiveness of single-acting reciprocating pumps in fluid transport, offering valuable insights into their performance over different operating times.

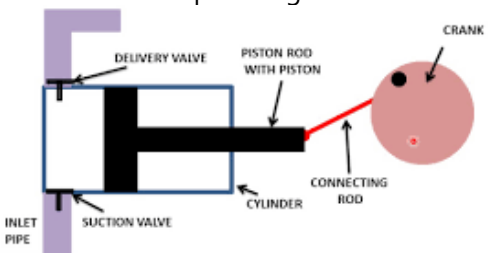

Fig 10: Single stage reciprocating pump

Try: How can triaxial compression testing be employed to comprehensively understand the mechanical behavior of different soil types under varying conditions, aiding geotechnical engineering design and analysis?

1. what considerations are essential for optimizing its intermittent and moderate flow performance?
2. In what ways does a single-acting reciprocating pump contribute to reliable and controlled fluid flow in applications like water supply and small-scale irrigation
3. how does its design align with providing intermittent pumping and moderate pressures for specific applications requiring controlled fluid movement?

V. TEXTBOOKS:

1. C.S.P. Ojha, R. Berndtsson and P. N. Chadramouli, "*Fluid Mechanics and Machinery*", Oxford University Press, 2010.
2. Modi, P. N., and S. M. Seth. "*Hydraulics and Fluid Mechanics"*. Standard Book House, 2011.
3. Subramanya, K. "*Theory and Applications of Fluid Mechanics",* Tata McGraw-Hill Education, 2013.

VI. REFERENCE BOOKS:

1. Hibbeler, R. C. "*Fluid Mechanics",* Pearson India Education Services Pvt. Ltd., 2022.
2. Som, S. K., Gautam Biswas, and Suman Chakraborty, "*Introduction to Fluid Mechanics"*, McGraw-Hill Education (India) Private Limited, 2010.
3. Banga, T. R., and S. C. Sharma, "*Hydraulic Machines"*, Khanna Publishers, 2019.

VII. ELECTRONICS RESOURCES:

1. http://site.iugaza.edu.ps/mymousa/files/Fluid-Mechanics-and-Hydraulics-Lab-Manual-2015-.pdf
2. http://www.public.asu.edu/~lwmays/classes/cee341/manual.pdf
3. https://issuu.com/loisburchette4023/docs/fluid-mechanics-lab-manual-for-mech

VIII. MATERIAL ONLINE:

1. Course outline description
2. Laboratory manual