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

COURSE CONTENT

THERMAL AND FLUIDS ENGINEERING LABORATORY							
IV Semester: ME							
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMED16	**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: Engineering Thermodynamics								

I. COURSE OVERVIEW:

The Thermal and Fluids Engineering Laboratory course is designed to provide students with hands-on experience in experimental techniques and data analysis related to thermal sciences and fluid dynamics. This course bridges theoretical knowledge with practical applications, enabling students to gain a deeper understanding of core engineering concepts.

II. COURSES OBJECTIVES:

The students will try to learn

I.   The fluid flow patterns and describes continuity equation.
II. How to calculate and draw characteristics curves for various experiments related to fluid mechanics.
III. The operating principle of C.I and S.I engines and to determine performance characteristics of engines.
IV. The Performance test for 4-stroke SI engine and draw performance curves and determine the volumetric efficiency and break thermal efficiency.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

1. Make use of the jet impact apparatus to investigate the reaction forces generated due to changes in momentum.
2. Utilize the pipe friction test apparatus to measure the friction factor under a range of flow rates and flow regimes for calculating major loses in closed pipes.
3. Infer the concept of calibrating orifice and venturi meter to minimize uncertainty in the discharge coefficient.
4. Distinguish the performance characteristics of Multi cylinder engine for various operating conditions.
5. Apply the concepts of intercooling in multistage air compressor for minimum power input.
6. Determine the performance parameters of internal combustion engines under variable input conditions for optimum fuel consumption.

EXERCISES ON MACHINE DRAWING THROUGH CAD

Note: Students are encouraged to bring their own laptops for laboratory practice sessions.

All dimensions are in mm in experiments.

Safety

Safety is a vital issue in all workplaces. Before using any equipment and machines or attempt practical work in a workshop everyone must understand basic safety rules. These rules will help keep all safe in the workshop.

Safety Rules

1. Always listen carefully to the teacher and follow instructions.
2. When learning how to use a machine, listen very carefully to all the instructions given by the faculty / instructor. Ask questions, especially if you do not fully understand.
3. Always wear an apron as it will protect your clothes and holds lose clothing such as ties in place.
4. Wear good strong shoes.
5. Bags should not be brought into a workshop as people can trip over them.
6. Do not use a machine if you have not been shown how to operate it safely by the faculty / instructors
7. Know where the emergency stop buttons are positioned in the workshop. If you see an accident at the other side of the workshop you can use the emergency stop button to turn off all electrical power to machines.
8. Wherever required, wear protective equipment, such as goggles, safety glasses, masks, gloves, hair nets, etc.
9. Always be patient, never rush in the workshop.
10. Always use a guard when working on a machine.
11. Keep hands away from moving/rotating machinery.
12. Use hand tools carefully, keeping both hands behind the cutting edge.
13. Report any UNSAFE condition or acts to instructor.
14. Report any damage to machines/equipment as this could cause an accident.
15. Keep your work area clean.

1. Getting Started Exercises
Introduction to fluid mechanics Laboratory

Understand the working principle of Venturimeter, and orifice meter used in the laboratory.

1. Become familiar with the operation and usage of fluid flow through pipes.
2. Learn to take readings of fluid level readings in manometer.

Try
1. Calculate the coefficient of discharge using Venturimeter experimental setup
2. Calculate the efficiency of the centrifugal pump, using the experimental setup

2. Determine the coefficient of discharge of Venturimeter
2.1 Venturimeter

Venturimeter is a flow measurement device, which is based on the principle of Bernoulli's equation. Inside the pipe pressure difference is created by reducing the cross-sectional area of the flow passage. Start the pump, operate the valves, measure the variations in manometer readings (h1 &h2), note down the time (t).

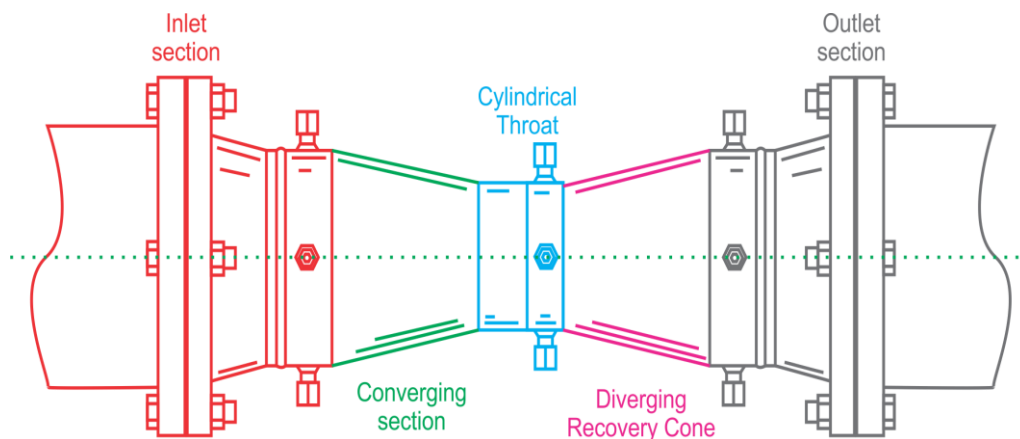**2.1 Calculate the coefficient of discharge using the experimental setup, shown in figure 1.**

Figure 1. Venturimeter

Try
1. Change the rate of convergence and divergence of venturi and repeat the same experiment
2. Open the valves half only and repeat the experiment and compare the results with full open condition
3. Open the valves to 2/3 and repeat the experiment and compare the results with full open condition

3. Determine the coefficient of discharge of Orifice Meter

3.1 Orifice Meter

The orifice meter is a type of inferential flow meter that utilizes an orifice plate with an aperture that is concentrically inserted into a pipeline in order to create the required constriction in the flow path.

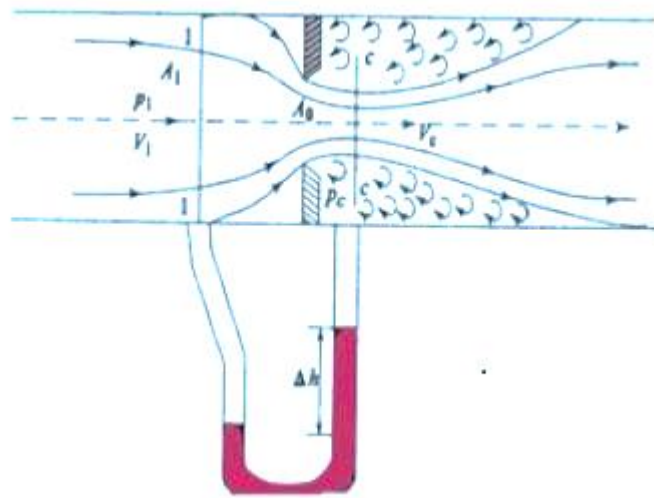**3.1 Calculate the coefficient of discharge of Orifice Meter shown in figure 2.**

Figure 2. Orifice meter

Try
1. Change the height of wedge fororifice and find the discharge coefficient
2. Open the valves half only and repeat the experiment and compare the results with full open Condition.
3. Change the height of the wedge for orifice, and find the discharge coefficient.

4. Find the friction factor for a square Pipe

4.1 Pipe Flow

Start the pump, operate the valves, measure the variations in manometer readings (h1 &h2), note down the time (t), and calculate the discharge, velocity and friction factor using the formula for given square pipes shown in figure 3.

Try
1. Change the roughness of a pipe and find the friction loses for a square pipe with full valves open
2. Change the dimensions of a pipe, open the valves half only and repeat the experiment for a square pipe and compare the results with full open condition
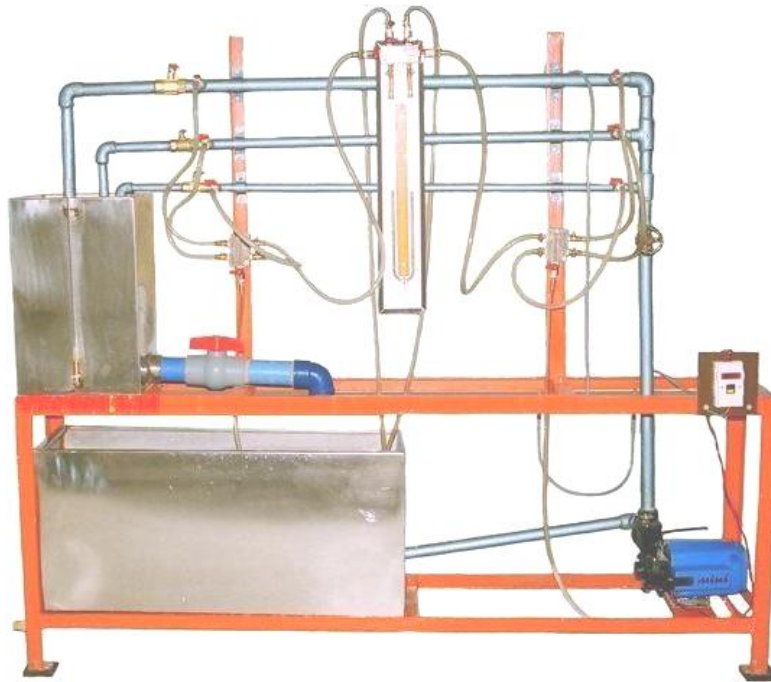
Figure 3. Flow through pipe experiment setup

5. Find the friction factor in Circular Pipe

5.1 Pipe Flow

Start the pump, operate the valves, measure the variations in manometer readings (h1 &h2), note down the time (t), and calculate the discharge, velocity and friction factor using the formula for given circular pipe.

Try

1. Change the roughness of a pipe and find the friction loses for a circular pipe with full valves open.
2. Change the dimensions of a pipe, open the valves half only and repeat the experiment for a circular pipe and compare the results with full opencondition

6. Exercises on Verification of Bernoulli's theorem.

6.1 Bernoulli's theorem

Bernoulli's theorem, also known as Bernoulli's principle, states that the whole mechanical energy of the moving fluid, which includes gravitational potential energy of elevation, fluid pressure energy, and kinetic energy of fluid motion, remains constant.

Start the pump, adjust the flow, note down the piezometer readings and time (t), calculate the pressure head, velocity head, and datum head, and verify the Bernoulli's Theorem shown in figure 4.
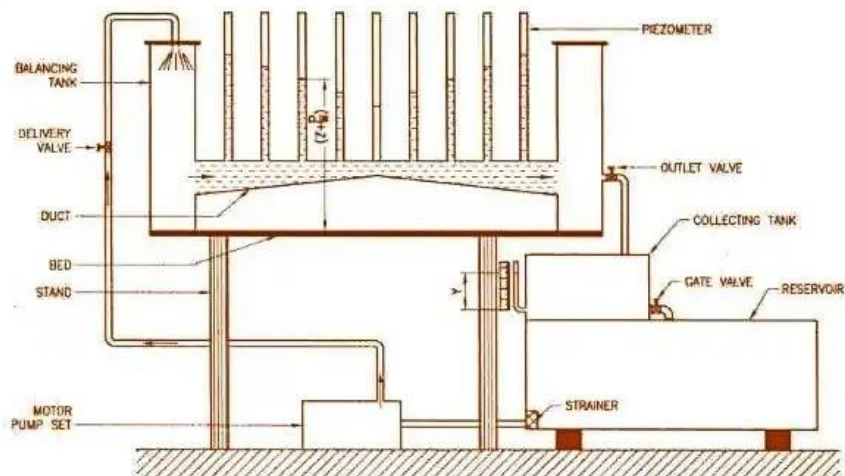
Figure 4: Bernoulli experiment setup

Try
1. Vary the mass flow rate and verify Bernoulli's theorem
2. Change the fluid type and verify Bernoulli's theorem

7. Find the mechanical and electrical efficiencies of Pelton Wheel Turbine

7.1 Pelton Wheel Turbine

Start the pump, adjust the nozzle opening about half, note down the pressure gauge, vacuum gauge readings, speed of the turbine, manometer readings (h1 & h2), and calculate output power, input power, and efficiency of the Pelton wheel turbine, using the experimental setup, shown in figure 5.
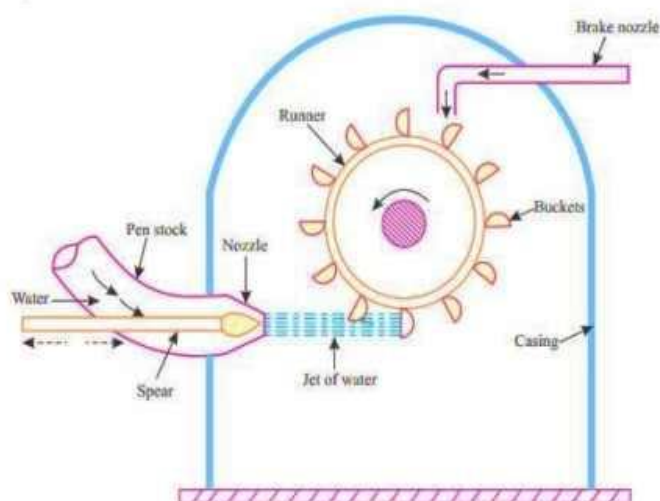

Figure 5: Schematic diagram of a Pelton turbine

Try

1. Adjust the nozzle opening for full, and calculate the efficiency of the Pelton wheel turbine
2. Note down the time for 30 cm rise of water and calculate the efficiency of the centrifugal pump
3. Performance characteristics of Pelton wheel turbine for change in the bucket design
4. Performance characteristics of Pelton wheel turbine for change in datum head

8. Port timing diagram of IC engine

A two-stroke (or two-stroke cycle) engine is a type of internal combustion engine that completes a power cycle with two strokes (up and down movements) of the piston during one power cycle, this power cycle being completed in one revolution of the crankshaft.

8.1 Plot the port timing diagram for engine.
Hint:
- Check the Inlet port, outlet port and transfer port in the figure 6
- Observe the piston and cylinder movement from bottom dead center to top dead center.
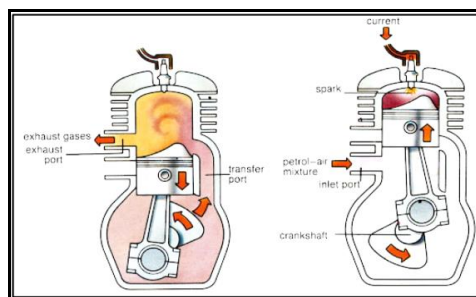- Observe the transfer port opening and closing.

Figure 6 Two stroke petrol engine

8.2 Plot the port timing diagram of an activa engine.
The new activa engine generation is mainly characterized by lower fuel consumption and fewer exhaust emission. To achieve low fuel consumption, a map-controlled oil pump, characteristic map thermostat and injection system with direct rail.

Try

1. Prepare the port timing diagram of two-cylinder petrol engine.
2. Prepare the port timing diagram of three-cylinder petrol engine.

9. Performance test for 2 stroke SI engine

A two-stroke engine is a type of internal combustion engine that completes a power cycle with two strokes of the piston during only one crankshaft revolution. This is in contrast to a four-stroke engine that requires four strokes of the piston to complete a power cycle during two crankshaft revolutions.

9.1 Performance test on 2-S Petrol engine as shown in figure 7.

Hints:
1) Check the petrol in the engine.
2) Check the battery and spark plug.

Fig. 7: 2 Stroke Engine

Try
1. Plot the thermal efficiency volumetric efficiency of 2 S stroke engine.
2. Plot the volumetric efficiency of 2 S stroke engine.

10. Performance test on 4 stroke spark ignition engine

A two-stroke engine is a type of internal combustion engine that completes a power cycle with two strokes of the piston during only one crankshaft revolution. This is in contrast to a four-stroke engine that requires four strokes of the piston to complete a power cycle during two crankshaft revolutions.
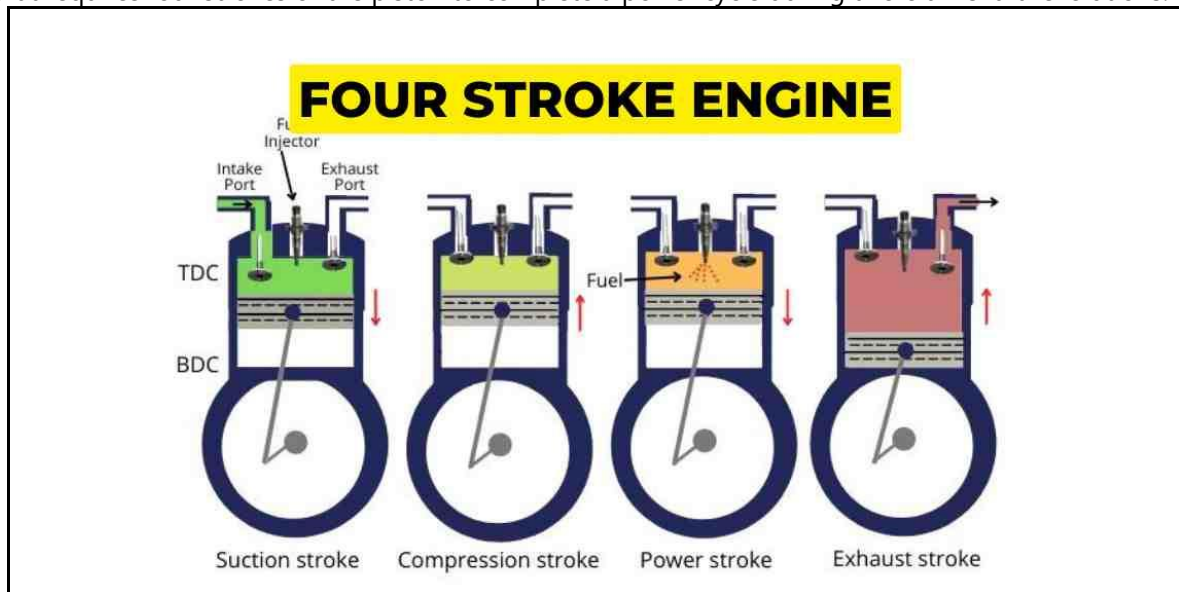

Figure 8: Performance test of 4-S SI engine

Try
1. Change the roughness of a pipe and find the friction loses for a square pipe with full valves open
2. Change the dimensions of a pipe, open the valves half only and repeat the experiment for a square pipe and compare the results with full open condition.

11. Morse test on a four- stroke

The purpose of morse test is to obtain the approximate Indicated Power of a Multi-cylinder Engine.

11.1 Performance of Morse Test on 4-cylinder 4-stroke petrol engine as shown in figure 9.

Hints:
1. The first cylinder is put on to working condition by operating the lever and the engine allowed to run for some time.
2. The fuel level and lubricating oil level are checked.
3. The second cylinder is cut-off and the load at which speed is maintained at 1500 rpm is noted.

Figure 9: Morse test

Try
1. Plot the chart between indicated power and brake power.
2. Determine the mechanical efficiency (ηm) of the engine.
3. Determine the firing order of 4-Cylinder petrol engine.

12. Heat balance for 4-stroke multi cylinder SI engine.

Heat balance sheet purpose to know the energy distribution that is how and where the input energy from the fuel is distributed.

12.1 Performance of on 4-cylinder 4-stroke diesel engine as shown in figure 10.

Hints:
i.   Before starting engine check the fuel supply, lubrication oil, and availability of cooling water.
ii. Engage the dynamometer after rated speed.
iii. Disengage the dynamometer and stop the engine.

Figure 10 Heat Balance of 4-S Diesel Engine

Try
1. Heat Balance sheet at engine rated speed 1000 RPM
2. Heat Balance sheet at engine rated speed 1500 RPM

13. Performance test on variable compression ratio engine

A variable compression ratio (VCR) engine is able to operate at different compression ratios, depending on the particular vehicle performance needs. The VCR engine is optimized for the full range of driving conditions, such as acceleration, speed, and load.

Figure 11 variable compression ratio engine diesel CI engine

Try
1. Performance characteristics of Pelton wheel turbine for change in the bucket design.
2. Performance characteristics of Pelton wheel turbine for change in datum head.

14. Volumetric efficiency of a reciprocating air compressor

An air compressor is a machine that takes ambient air from the surroundings and discharges it at a higher pressure. It is an application of a gas compressor and a pneumatic device that converts mechanical power.

14.1 Determine volumetric efficiency of an air compressor.
Hints:
i) The apparatus consists of a stainless-steel tube fitted in a rectangular duct in a vertical position as shown in figure 12.
ii) The duct is open at the top and bottom and forms an enclosure and serves the purpose of undisturbed surroundings.
iii) One side of the duct is made of acrylic sheet for visualization.

Figure 12 Reciprocating air compressors

Try

1. Adjust the nozzle opening for 2/3, and calculate the efficiency of the Francis turbine
2. Adjust the nozzle opening for full, and calculate the efficiency of the Francis turbine
3. Performance characteristics of Francis turbine for change in the vane angle
4. Performance characteristics of Francis turbine for change in datum head

V. TEXT BOOKS:

1. S.P. Sukhatme and J.K. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, McGraw-Hill Education, 2018.
2. D.P. Kothari, K.C. Singal, and Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, PHI Learning Pvt. Ltd., 2016.

VI. REFERENCE BOOKS:

1. John Twidell and Tony Weir, *Renewable Energy Resources*, Taylor & Francis, 2015.
2. Godfrey Boyle, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 2014.
3. B.H. Khan, *Non-Conventional Energy Resources*, McGraw-Hill Education, 2017.

VII. ELECTRONICS RESOURCES:

1. https://nptel.ac.in/courses/112108149.
2. https://www.google.co.in/webhp?sourceid=chrome instant&ion=1&espv=2&ie=UTF8#q=fem%20notes
3. https://www.kth.se/social/upload/5261b9c6f276543474835292/main.pdf.
4. https://akanksha.iare.ac.in/index?route=course/details&course_id=1293

VIII. MATERIALS ONLINE:

1. Course Template
2. Lab Manual