GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Mechanical Engineering & Mechanical Engineering (CAD/CAM)

Course / Subject Code: DI03000171

Course / Subject Name: Fluid Mechanics and Hydraulic Machinery

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	Professional Core Course

Prerequisite:	Applied Physics, Applied Mathematics
Rationale:	This course is intended to introduce the basic principles of fluid Mechanics. The main objective of this course is to understand the fundamentals of fluid mechanics, such as fluid and flow properties, fluid behavior at rest and in motion, and fundamental equations like mass, momentum, and energy conservation of the fluid flow, thereby developing an understanding of fluid dynamics in a variety of fields. The knowledge of fluid properties, fluid flow, and fluid machinery is essential in many fields of engineering. This course aims to develop the skills that will enable the students to select appropriate pressure and flow-measuring devices (Pressure gauge, rotameter, etc.) and machines (pumps, turbines, etc.) for a particular application.

Course Outcome:

After Completion of the Course, the Student will be able to:

No	Course Outcomes
01	Understand fluid properties and apply pressure measurement methods to real-life applications.
02	Apply fluid flow principles to solve problems related to fluid behavior in practical engineering systems.
03	Apply the principle of the impact of a jet on various surfaces.
04	Select appropriate hydraulic machine based on system requirements.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**UNIT-I: Fluid Properties & Pressure Measurement:** **Fluid properties:** Concept of fluid and its type, Density, Specific Weight, Specific Volume, Specific gravity, Bulk Modulus, Compressibility, Dynamic Viscosity, Kinematic Viscosity, Surface tension, Capillarity, Vapor Pressure, Numerical Problems. **Fluid Pressure and Measurement:** Fluid pressure, Pressure head, Pascal's Law with derivation, Concept of vacuum and gauge pressure, atmospheric pressure, absolute pressure, Numerical Problems, Concept of Total pressure and center of pressure (No derivation) on a vertical immersed body, Pressure Measuring Devices, Numerical problems on Manometers.	**08**	**17.7**
2.	**Unit-II: Fluid Flow and Measurement:** **Fluid Flow:** Stream line, Streak line, Path line and Stream tube, Types of fluid flow, Continuity & Momentum Equation, Bernoulli's theorem and its derivation from energy and Euler's equation, assumption, limitations, application, Numerical problems. **Fluid Flow Measurement:** Principle of operation of Venturimeter, Orifice meter (no derivation), and Pitot tube, Concept of Rotameter, Hydraulic coefficients, Numerical problems. **Flow Through Pipes:** Major and Minor (concept) losses, Reynold's experiment, Darcy's and Chezy's equations (with derivation), Numerical problems, Water hammer its cause, effect, and remedies.	**15**	**33.3**
3.	**Unit-III: Impact of Jet:** Impact of jet on vertical flat and curved plate (Fixed, Moving and Series), Impact of jet on curved vanes with special reference to turbines & pumps, Simple Numerical problems on work done and efficiency.	**07**	**15.7**
4.	**Unit-IV: Hydraulic Machines:** **Hydraulic Turbine:** Layout of hydroelectric power plant, Features of hydroelectric power plant, Heads and efficiencies of turbine, Classification of hydraulic turbines, Construction and working principle of Pelton wheel, Francis and Kaplan turbines, Draft tubes – types and construction, Selection of turbine based on head, specific speed and discharge available, Specific	**15**	**33.3**

	speed, Work done, Power, efficiency of turbine, Numerical problems, Concept of cavitation in turbines. **Pumps:** Function, classification and application of pump, Heads and efficiencies of pump, Construction and working of centrifugal pump, types of casings and impellers, Concept of multistage, Priming and its methods, Minimum suction depth, Construction and working of single and double acting reciprocating pump, Air vessel, Overall efficiency, Power required, Numerical Problems, Concept of Slip, Negative slip, Cavitation and separation.		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
14	21	35	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Hydraulics, Fluid Mechanics and Hydraulic Machines - R.S. Khurmi, S. Chand Publishing, New Delhi.
2. Fluid Mechanics and Hydraulic Machines – R. K. Bansal, Laxmi Publications, New Delhi.
3. Fluid Mechanics and Hydraulic Machines – R. K. Rajput, S. Chand & Company Ltd.
4. Hydraulics and fluid mechanics including Hydraulic machines – Modi P.N. and Seth S.M., Standard Book House. New Delhi.
5. Hydraulic, fluid mechanics & fluid machines – Ramamrutham S, Dhanpath Rai and Sons, New Delhi.
6. One Thousand Solved Problems in Fluid Mechanics – K. Subramanya, Tata McGraw Hill.
7. Fluid Mechanics, Fundamentals, and Applications- Yunus A. Cengel, John M. Cimbala- MC-Graw Hill, Higher Education.
8. Fluid Mechanics & Hydraulic Machines- S S Rattan, Khanna Book Publishing Co., New Delhi.

(b) Open-source website:

1. https://nptel.ac.in/courses/112105206
2. https://nptel.ac.in/courses/112103249
3. https://me.iitp.ac.in/Virtual-Fluid-Laboratory/
4. https://fmc-nitk.vlabs.ac.in/
5. https://fm-nitk.vlabs.ac.in/

6. https://eerc03-iiith.vlabs.ac.in/
7. https://www.youtube.com/watch?v=HhjkDGRjMBk&list=PLagszcJQfPU3yUodnZQsgD_YDVvtE-jJD&index=11
8. https://archive.nptel.ac.in/content/storage2/courses/112104117/ui/Course_home-lec33.htm

Suggested Course Practical List:

Sr. No.	Suggested Practical	Hours
1	Demonstration of Fluid Properties.	2
2	Measurement of Pressure using Measuring Devices (Manometer, Pressure Gauge).	2
3	Verification of Bernoulli's Theorem.	2
4	Measure fluid flow by Venturi meter/orifice meter/rotameter/pitot tube.	4
5	Determine hydraulic coefficients using an orifice.	2
6	Estimate Reynold's number using the given test rig.	2
7	Determine Friction Factor for Pipes.	2
8	Determine the force exerted by the jet of water on the given plate.	2
9	Trial on Pelton wheel/Kaplan/Francis to determine overall efficiency.	4
10	Trial on centrifugal pump to determine overall efficiency.	2
11	Trial on reciprocating pump to determine overall efficiency.	2
12	Student Activities. *	4
	Total Hours	**30**

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name
1	Different manometers, pressure gauge.
2	Hydraulic test rig compressing facility to verify Bernoulli's theorem, venturi meter, orifice meter, pitot tube, rotameter, orifice, and major & minor losses through pipes.
3	Centrifugal pump test rig.
4	Reciprocating pump test rig.
5	Hydraulic prime mover test rig.
6	Reynold's Apparatus.
7	Impact of Jet Apparatus.

***Suggested Activities for Students:**

1. Prepare a tabulated summary of the types of pipes available in the market. (The summary includes type, specification, size range, material, rate, and applications).
2. Identify any one hydraulic pump and one prime mover available in the market with detailed specifications and current prices.
3. Select at least three problems on the manometer and prepare a report containing their solutions.

4. Select at least three problems regarding the continuity equation and prepare a report containing their solutions.
5. Select at least three problems regarding the impact of jet and prepare a report containing their solutions.
6. Select at least three problems regarding Bernoulli's equation and prepare a report containing their solutions.
7. Select at least five problems regarding discharge measurement and prepare a report containing their solutions.
8. Select at least three problems to determine major and minor losses and prepare a report containing their solutions.
9. Select at least two problems to type of flow (Based on Reynold's number) and prepare a report containing their solutions.
10. Select at least two problems to determine the power/efficiency of the Reciprocating and Centrifugal pump and prepare a report containing their solutions.
11. Compare the following liquids concerning their density (for the same mass, compare the volume) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
12. Arrange the situations of H_2O at atmospheric pressure in ascending order (with reason) concerning their density. (a) Ice at -10°C, (b) Water at 30°C, (c) Water at 100°C (d) Dry and saturated Steam at 100°C
13. Arrange the situations of H_2O at an atmospheric temperature in ascending order (with reason) concerning their density. (a) Water at atmospheric pressure, (b) Water at 10 bar, (c) Water at 40 bar
14. Compare the following liquids concerning their viscosity (for the same temperature, compare the velocity) (1) Petrol (2) Water (3) Edible oil (4) Caster oil (5) Mercury.
15. Calculate the water weight when your home's water tank is completely filled with water.
16. Observe the working of a Hydraulic Jack at any garage and relate it with Pascal's law.
17. Observe the discharge water condition from a pipe at the time of car washing with a nozzle and without a nozzle and explain the difference considering Bernoulli's equation.
18. Observe discharge water condition from a pipe at fully and partially opened cock/valve/tap and explain the difference considering the continuity equation.
19. Draw a line diagram of the water supply & distribution line of your hydraulic lab and indicate the source of major and minor losses in it.
20. Select a pump for a coolant recirculation in a lathe machine, garage pump for car washing, Bore well pump, pump at a service station, pump used in water coolers, or pump in a purified water filter system with justification.
21. Download/collect a catalogue of pump manufacturers like Kirloskar, Shakti, Jyoti, Lubi, KSB, Havells, etc., and compare their parameters.
22. Prepare a display chart of types of pipes based on material. Size and applications.

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