Program Name : **Diploma in Mechanical Engineering**

Program Code : **ME**

Semester : **Fourth**

Course Title : **Fluid Mechanics and Machinery**

Course Code : **22445**

1. RATIONALE

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, diagonose and rectify the faults in pumps and turbines, replace pressure gauges and other accessories on hydrauic machines turbines, and apply their knowledge in hydraulics to select appropriate devices like pressure gauges, valves, flow devices, pipes etc for different field applications.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

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

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

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.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment,* @ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

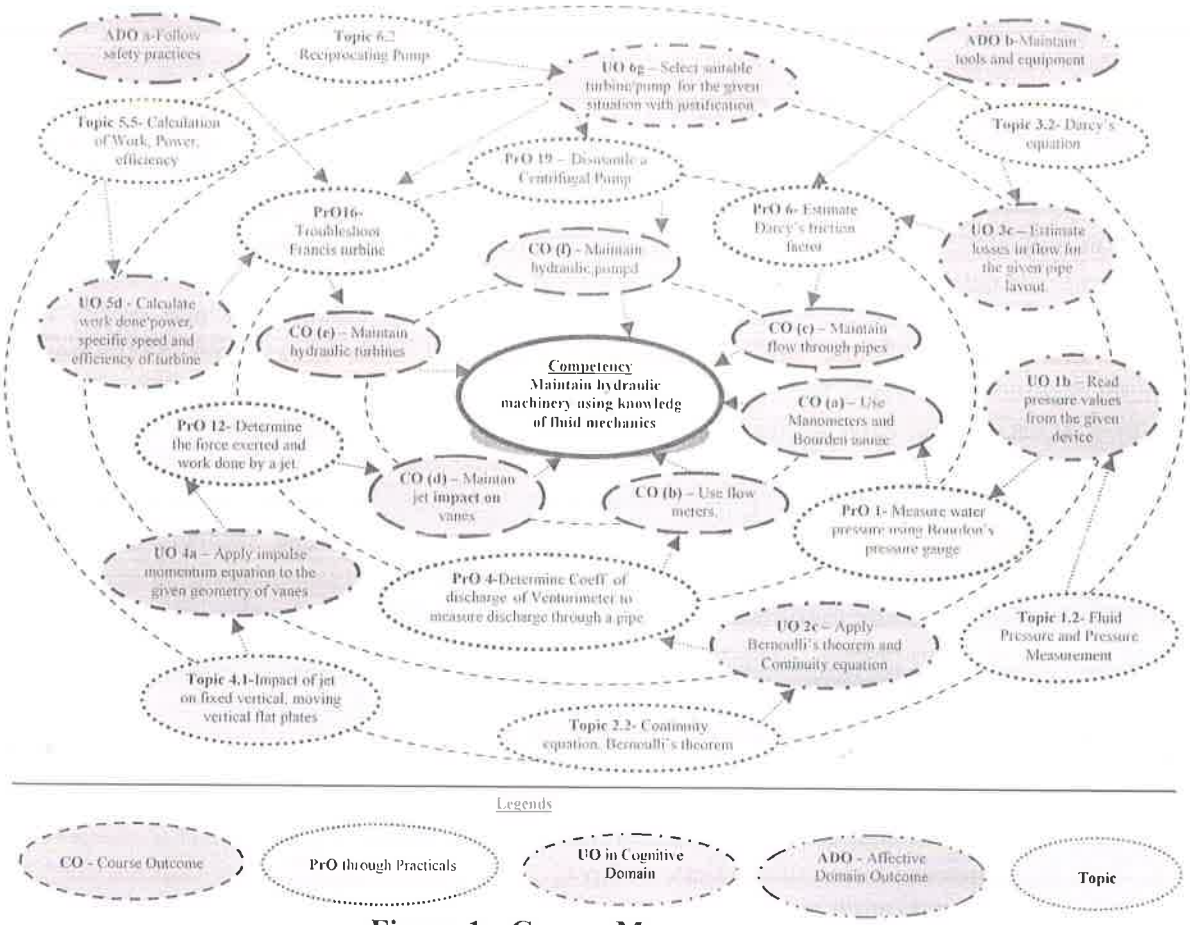

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
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.	I	02*
2	Measure Total Energy available at different sections of a pipe layout	II	02
3	Use Venturimeter to measure discharge through a pipe	II	02*
4	Use Sharp edged circular orifice to measure discharge through a pipe	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5	Estimate Darcy's friction factor 'f' in pipes of three different diameters for four different discharges	III	02
6	Determine frictional losses in sudden expansion and sudden contraction in pipe.	III	02*
7	Determine frictional losses in bend in pipe.	III	02
8	Determine frictional losses in elbow in pipe.	III	02
9	Determine the force exerted by a jet on flat plate	IV	02
10	Use Pelton wheel test rig to determine overall efficiency	V	02
11	Dismantle a Centrifugal pump.	VI	02*
12	Assemble a Centrifugal pump.	VI	02*
13	Determine overall efficiency of Centrifugal Pump	VI	02
14	Dismantle a Reciprocating pump	VI	02*
15	Assemble a Reciprocating pump	VI	02*
16	Determine overall efficiency of Reciprocating pump using Reciprocating pump test rig.*	VI	02*
17	Determine percent slip of Reciprocating pump.	VI	02
	Total		**34**

Note

i. 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.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety and ethical practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Maintain tools and equipment.

f. Update yourself about the latest advancements happening in the field of fluid mechanics and machinery.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Bernoulli's theorem Apparatus.	1,3
2	Dead weight pressure gauge calibrater.	2
3	Flow measuring devices (Venturimeter/ orifice meter) Apparatus.	4
4	Hydraulic coefficient test rig.	5
5	Determination of major losses /minor losses in pipe fittings Apparatus.	6 to 11
6	Impact of jet test rig	12
7	Pelton wheel test rig.	13, 14
8	Francis turbine test rig	15
9	Turbine turbine test rig	16
10	Centrifugal pump test rig.	19 t0 21
11	Reciprocating pumps test rig.	22 to 25

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Properties of Fluid and Fluid Pressure	1a. Compare the given two fluids based on the given physical properties. 1b. Convert the pressure values from the chart of the given device and into the specified units. 1c. Choose the relevant pressure measuring device for the given situation with justification. 1d. Select the relevant pressure measuring devices for the given	1.1 Properties of Fluids: Density, Specific gravity, Specific volume, Specific Weight, Dynamic viscosity, Kinematic viscosity, Surface tension, Capillarity, Vapour, Pressure, Compressibility 1.2 Fluid Pressure and Pressure Measurement: Fluid pressure, Pressure head, Pressure intensity, Concept of absolute vacuum, gauge pressure, atmospheric pressure, absolute pressure; Simple and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	application with justification. 1e. Calculate fluid pressure, total pressure and centre of pressure on the given immersed body in the specified liquid and the given position.	differential manometers, Bourden pressure gauge; Total pressure, center of pressure on- regular surface immersed in given liquid in horizontal, vertical and inclined Positions.
Unit-II Fluid Flow	2a. Compare the types of fluid flow based on the given characteristic properties. 2b. Choose the relevant discharge measuring device for the given situation with justification. 2c. Apply Bernoulli's theorem and Continuity equation to the given discharge measuring device and data. 2d. Choose the relevant discharge measuring device for the given application with justification. 2e. Describe with sketches the procedure to calculate discharge using the given flow meter.	2.1 Types of fluid flows-Laminar, turbulent, steady, unsteady, uniform, non uniform, rotational, irrotational, one, two and three dimensional flow. 2.2 Continuity equation, Bernoulli's theorem. 2.3 Venturimeter – Construction, principle of working, coefficient of discharge, Derivation for discharge through venturimeter 2.4 Orifice meter – Construction, Principle of working, hydraulic coefficients. Derivation for discharge through Orifice meter 2.5 Pitot tube – Construction, Principle of Working
Unit– III Flow through Pipes	3a. Use laws of fluid friction for the given Laminar and turbulent flow. 3b. Use Darcy's equation and Chezy's equation for the given frictional losses. 3c. Estimate losses in flow for the given pipe layout. 3d. Calculate power transmitted and transmission efficiency for the given pipe layout and data.	3.1 Laws of fluid friction for Laminar and turbulent flow; Darcy's equation and Chezy's equation for frictional losses. 3.2 Minor losses in pipe fittings and valves; Hydraulic gradient line and total energy line. 3.3 Hydraulic power transmission through pipe 3.4 Water hammer phenomenon in pipes, causes and remedial measures.
Unit– IV Impact of Jet	4a. Apply impulse momentum equation to the given geometry of vanes and find equation for force and work done. 4b. Calculate force exerted by a jet, work done and efficiency for the given vane and data. 4c. Draw velocity diagram for the given curved vane with special reference to turbines. 4d. Draw velocity diagram for the given curved vane with special reference centrifugal pumps.	4.1 Impact of jet on fixed vertical, moving vertical flat plates. 4.2 Impact of jet on curved vanes with special reference to turbines and Pumps.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Hydraulic Turbines	5a. Select the hydraulic turbine fo the given application with justification. 5b. Calculate work done, power, specific speed and efficiency of the given turbine and data. 5c. Describe with sketches the functioning of the given types of Draft tubes. 5d. Draw characteristic curves of the given turbine. 5e. Describe the procedure to troubleshoot the given type of hydraulic turbine with skethes.	5.1 Layout and features of hydroelectric power plant, surge tanks and its need. 5.2 Classification of hydraulic turbines and their applications. 5.3 Construction and working principle of Pelton wheel, Francis and Kaplan turbine. 5.4 Draft tubes – types and construction. Concept of cavitation in turbines. 5.5 Calculation of Work done, Power, efficiency of turbine.
Unit –VI Pumps	6a. Select the relevant hydraulic pumps fo the given application with justification. 6b. Calculate work required and efficiency of the given centrifugal pump ad data. 6c. Draw characteristic curves of the given pump. 6d. Calculate slip, efficiencies, and power required to drive the given reciprocating pump and data. 6e. Select the suitable pump for the given situation with justification. 6f. Describe the procedure to troubleshoot the given type of hydraulic pump with sketches.	6.1 Centrifugal Pumps: Construction, principle of working, priming methods and Cavitation; Types of casings and impellers; Static head Manometric head, Work done, Manometric efficiency, Overall efficiency. Numericals based on above parameters, NPSH, Performance Characteristics of Centrifugal pumps and its trouble shooting, Construction, working and applications of multistage pumps. Working principle and applications of Submersible pumps and Jet pump. 6.2 Reciprocating Pump: Construction, working principle and applications of single and double acting reciprocating pumps; Slip, Negative slip, Cavitation and separation. Use of Air Vessels; Indicator diagram with effect of acceleration head and frictional head; Pump selection criteria- head, discharge

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Properties of Fluid and Fluid Pressure	12	02	02	04	08
II	Fluid Flow	10	02	04	06	12
III	Flow through Pipes	10	02	04	06	12
IV	Impact of Jet	06	00	04	04	08
V	Hydraulic Turbines	12	02	04	08	14
VI	Pumps	14	04	04	08	16
Total		**64**	**12**	**22**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various mechanical measuring instruments and equipments related to fluid mechanics and machinery.
d. Read and use specifications of the hydraulic machines and equipments.
e. Library / Internet survey of hydraulics and hudraulic machines
f. Prepare power point presentation or animation for understanding constructional details and working of different hydraulic machines.
g. Visit nearby shops to identify different PVC and GI pipe fittings. Collect manufacturing catalogues related to the same.
h. Visit nearby shops to identify different pumps. Collect manufacturing catalogues related to the same and compare their salient features.
i. Prepare a list of commercially available software related to computational Fluid dynamics (CFD).

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Correlate subtopics with actual domestic and industrial fluidic systems.
g. Use proper equivalent analogy to explain different concepts.
h. Use Flash/Animations to explain various fluid machinery and pipe line.
i. Use open source simulation software.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a pipe layout water suppy of your lab from supply reservoir and calculate the loss of head.
b. Prepare a chart of showing all the pressure and flow measuring devices.
c. Prepare a demonstration model of hydroelectric power plant.
d. Calculate running cost of your house hold pump and verify the electricity bill.
e. Gather information of hydroelectric power plants in Maharashtra, India and world.
f. Visit a hydroelectric power plant and write report.
g. Make a video to explain the Hydraulic power generation which could be understood by common man.
h. Select a pump for a coolant recirculation in lathe machine, Bore well pumps, pump at service station, pump used in water coolers, pump in purified water filter system with justification.
i. Download catalogue of pump manufacturer like kirloskar, cri,texmo,etc and compare their parameters.
j. Dissemble and assemble centrifugal pump for fault finding, troubleshooting and to identify wornout parts.
k. Prepare display chart of types of pipes on the basis of mareial, size and applications.
l. Study pressure gauges used by road side tyre worrks, blood pressure measurement by doctors., pressure gauges mounted on turbine test rig.
m. Visit to nearby pump manufacturing unit
n. Conduct market survey of pump suppliers and prepare report on technical specifications, area of applications, cost, material of different parts and maintenance procedure.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Hydraulics and Fluid Mechanics including Hydraulic Machines	Modi P.N. Seth S M	Standard Book House New Delhi, 2013. ISBN 978818940126
2	Fluid Mechanics and Hydraulic m/c	Bansal R. K.	Laxmi Publication Pvt. Ltd. New Delhi, 2013, ISBN 9788131808153
3	A text book of Fluid Mechanics and Hydraulic Machines	Rajput R. K.	S. Chand and Company Pvt. Ltd. New Delhi, 2000, ISBN 9789385401374
4	Fluid Mechanics and Hydraulic Machines: problems and solution	Subramanya K.	Tata McGraw-Hill Co. Ltd. New Delhi 2011, ISBN 9780070699809
5	Fluid Mechanics and Machinery	Ojha, Berndtsson, Chnadramouli	Oxford University Press, New Delhi 2000, ISBN 9780195699630
6	Introduction to Fluid Mechanics and Fluid Machines	Som S. K. , Biswas G.	Tata McGraw-Hill Co. Ltd. New Delhi 2005, ISBN 9780070667624
7	A Textbook of Hydraulics, Fluid Mechanics and Hydraulic Mechanics	Khurmi R. S.	S. Chand and Co. Ltd. New Delhi 2015, ISBN-13: 9788121901628
8	Hydraulic, fluid mechanics and fluid machines	Ramamrutham S.	Dhanpat Rai and Sons New Delhi 2011, ASIN: 8187433809
9	Fluid Mechanics	Streeter Victor, Benjamin Wylie E., Bedford K.W.	McGraw Hill Education; New Delhi, 2017,ISBN 978-0070701403
10	Hydraulic Machines	Jagdish lal	Metropolitan; 2008, ISBN-13: 9788120004221

14. SOFTWARE/LEARNING WEBSITES

a. www.nptel.ac.in/courses
b. www.learnerstv.com www.ni.com/multisim
c. https://www.youtube.com/watch?v=e6a2q9k2JCA
d. https://www.youtube.com/watch?v=5TTnFccqJEE
e. https://www.youtube.com/watch?v=3Gq3tR3fkM0
f. https://www.youtube.com/watch?v=UNBWI6MV_IY
g. https://www.youtube.com/watch?v=ljMVt7T4HQM
h. https://www.youtube.com/watch?v=wnOQMk7pKak
i. https://www.youtube.com/watch?v=IcJOkRZPNMI
j. https://www.youtube.com/watch?v=w7n0srAzm8g
k. https://www.youtube.com/watch?v=f9LY0-WP9Go
l. https://www.youtube.com/watch?v=tXLI-IeAynI

m. https://www.youtube.com/watch?v=qbyL--6q7_4
n. https://www.youtube.com/watch?v=3BCiFeykRzo
o. https://www.youtube.com/watch?v=0p03UTgpnDU
p. https://www.youtube.com/watch?v=BaEHVpKc-1Q
q. https://www.youtube.com/watch?v=oQqMrtc6kJQ