Program Name : **Civil Engineering Program Group**

Program Code : **CE/CR/CS**

Semester : **Fourth**

Course Title : **Hydraulics**

Course Code : **22401**

1. RATIONALE

It is necessary for Civil Engineering technologist to understand the behaviour of fluid flow in different water carriages. Basics of hydraulics and its application oriented content will help them to solve practical problems in the field of Water Resources, Irrigation, Environmental Engineering and Public health Engineering.

2. COMPETENCY

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

- **Apply hydraulics principles in water carriage systems and water retaining structures.**

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. Interpret the pressure parameters from pressure measuring devices in flowing liquids.
b. Determine total hydrostatic pressure and centre of pressure for different conditions.
c. Use relevant fluid flow parameters in different situations.
d. Determine the loss of head of fluid flow through pipes.
e. Find the fluid flow parameters in open channels.
f. Select relevant hydraulic pumps for different applications.

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
3	2	2	7	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.*

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.

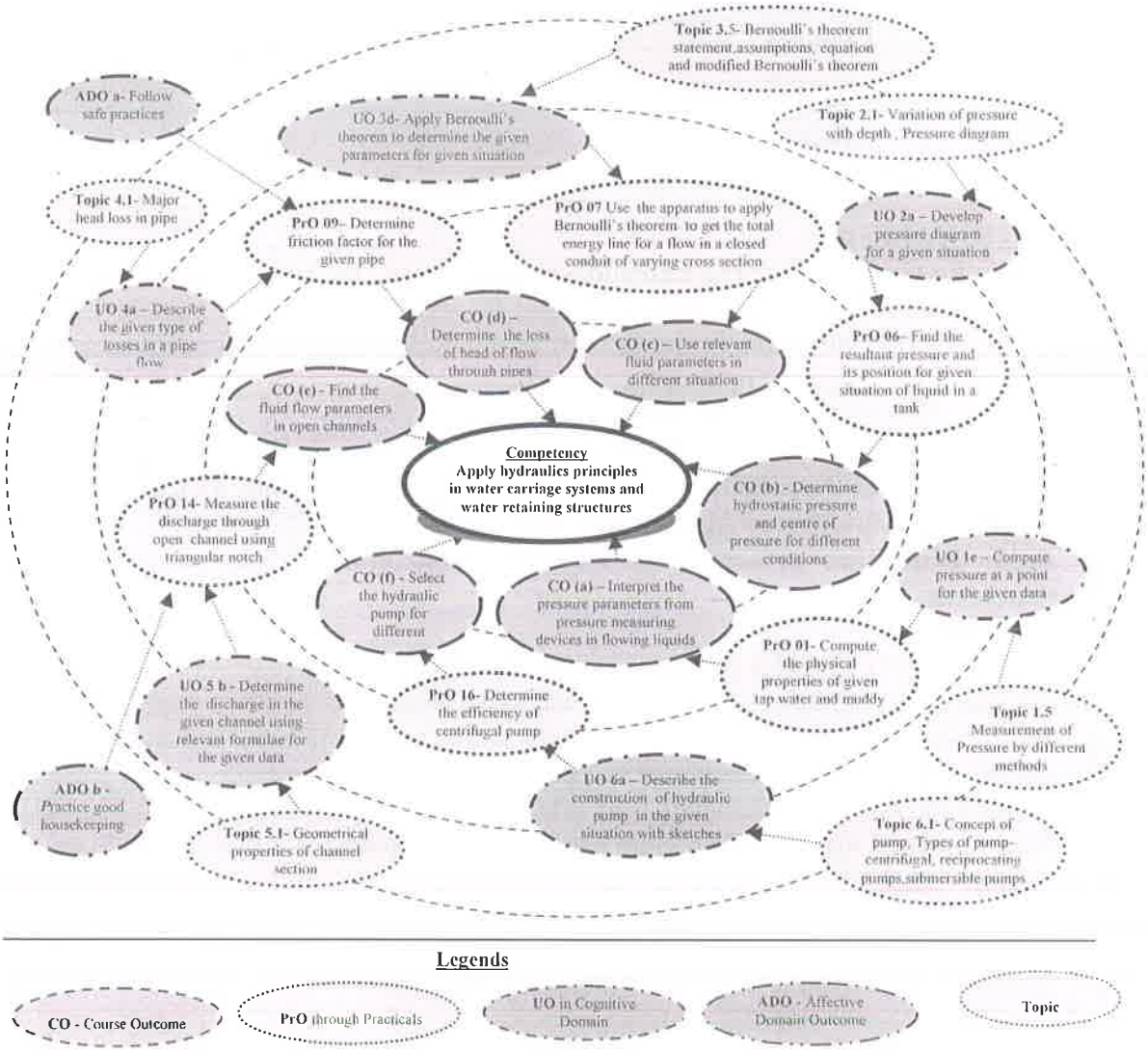

Figure 1 - Course Map

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	Compute the physical properties of given tap water and muddy water	I	02*
2	Compute the physical properties of given oil and Mercury	I	02
3	Use the piezometerto measure the pressure at a given point.	I	02
4	Use the Bourdon Gauge to measure the pressure at a given point.	I	02
5	Use the U tube differential manometer to measure the pressure difference between two given points.	I	02*
6	Find the resultant pressure and its position for given situation of liquid in a tank.	II	02*
7	Use the Reynold's apparatus to interpret type of flow	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Use the Bernoulli's apparatus to apply Bernoulli's theorem to get the total energy line for a flow in a closed conduit of varying cross sections.	III	02*
9	Use the Friction factor Apparatus to determine friction factor for the given pipe.	IV	02*
10	Determine the minor losses in pipe fittings due to sudden contraction and sudden enlargement.	IV	02*
11	Determine the minor losses in pipe fitting due to Bend and Elbow	IV	02
12	Calibrate the Venturimeter to find out the discharge in a pipe.	IV	02*
13	Calibrate the Orifice to find out the discharge through a tank	IV	02*
14	Use the current meter to measure the velocity of flow of water in open channel.	IV	02
15	Use the Pitot tube to measure the velocity of flow of water in open channel.	IV	02
16	Use the Triangular notch to measure the discharge through open channel.	V	02*
17	Use the Rectangular Notch to measure the discharge through open channel	V	02
18	Determine the efficiency of centrifugal pump.	VI	02*
	Total		**36**

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 LOs/tutorials 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. Hence, the 'Process' and 'Product' related skills associated with each PrO of the laboratory/workshop/field work are to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	10
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	20
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 safe practices
b. Practice good housekeeping
c. Practice energy conservation

d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. Follow ethical practices

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	Measuring cylinder, Weighing balance	01, 02
2	Piezometer	03
3	Bourdon tube pressure gauge	04
4	U tube differential manometer, Mercury	05
5	Reynold's apparatus, colour dye, Stop watch	06
6	Bernoulli's apparatus, Stop watch	07
7	Friction factor Apparatus, Stop watch	08
8	Apparatus for finding minor losses in the pipe, Stop watch	09
9	Pipe setup, bend, elbow fittings, stop watch	10
10	Pipe set up fitted with Venturimeter, U tube differential manometer, Stop watch	11
11	Current meter, stop watch	12
12	Pitot tube, stop watch	13
13	Channel set up with different notches, Stop watch	14
14	Centrifugal pump set up	15

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Pressure measurement	1a. Describe the role of hydraulics in the given civil engineering application. 1b. Compute different properties of liquid from given data. 1c. Convert gauge pressure into absolute pressure for the given data and viceversa.	1.1 Technical terms used in Hydraulics – fluid, fluid mechanics, hydraulics, hydrostatics, and hydrodynamics-ideal and real fluid, application of hydraulics in Civil Engineering field. 1.2 Physical properties of fluid – density-specific volume, specific gravity-surface tension-capillarity, viscosity-

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Convert pressure head of one liquid to that of another liquid for the given data. 1e. Compute pressure at a point for the given data. 1f. Compute pressure difference between two points for the given data.	Newton's law of viscosity 1.3 Various types of pressure – Atmospheric Pressure- Gauge Pressure-Absolute Pressure-Vaccume Pressure, Concept of Pressure Head and its unit, Pascal's law of fluid pressure and its uses. 1.4 Conversion of pressure head of one liquid in terms of other liquid. 1.5 Measurement of Pressure by different methods(By Piezometer, simple manometers and Bordon pressure Gauge) 1.6 Measurement of difference of pressure by differential U tube manometers and inverted U tube manometers
Unit-II Hydrostatics	2a. Develop pressure diagram for a given situation. 2b. Determine total pressure and centre of pressure for given immersed surface with sketches. 2c. Find the resultant pressure and its position for given situation of liquid in a tank. 2d. Find the resultant pressure and its position for the given liquid on either side of the partition wall.	2.1 Variation of pressure with depth , Pressure diagram –concept and use 2.2 Total hydrostatic pressure and center of pressure on immersed surfaces and on tank walls 2.3 Determination of total pressure and center of pressure on vertical, inclined and horizontal immersed surfaces. 2.4 Determination of total pressure and center of pressure on sides and bottom of water tanks, sides and bottom of tanks containing two liquids, vertical surface in contact with liquid on either side
Unit– III Fluid Flow Parameters	3a. Differentiate the given types of flow. 3b. Interpret the type of flow using Reynold's number 3c. Calculate velocity and discharge in the given situation using continuity equation. 3d. Apply Bernoulli's theorem to determine the given parameters for given situation. 3e. Apply Modified Bernoulli's theorem to determine the given parameters for given situation	3.1 Types of flow – Gravity and pressure flow, Laminar -Turbulent -Uniform - Non-uniform –Steady-Unsteady flow 3.2 Reynold's number 3.3 Discharge and its unit, continuity equation of flow. 3.4 Energy of flowing liquid: potential, kinetic and pressure energy. 3.5 Bernoulli's theorem : statement, assumptions, equation and modified Bernoulli's theorem
Unit– IV Flow through	4a. Describe the given type of losses in a pipe flow. 4b. Use Darcy Weisbach equation to	4.1 Major head loss in pipe: Frictional loss and its computation by Darcy

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
pipes	find out the head loss due to friction for the given data. 4c. Compute the discharge in the given network (Parallel or series) of pipes. 4d. Apply Dupit's equation to determine the equivalent pipe for given data. 4e. Use Moody's diagram to find diameter of pipe from given data. 4f. Use nomogram to find diameter of pipe from given data. 4g. Calculate discharge in a pipe for the given data using Venturimeter.	Weisbach equation $h_f = \frac{flv^2}{2gD}$ 4.2 Minor losses in pipe: loss at entrance, exit, sudden contraction, sudden enlargement and fittings. 4.3 Flow through pipes in series, pipes in parallel and Dupit's equation for equivalent pipe 4.4 Hydraulic gradient line and total energy line 4.5 Water hammer in pipes : causes and Remedial measures 4.6 Use of Moody's Diagram and Nomograms. 4.7 Discharge measuring device for pipe flow: Venturimeter-construction and working 4.8 Discharge measuring for a tank: using Orifice, Hydraulic Coefficients of Orifice.
Unit –V Flow through Open Channel	5a. Describe the geometrical properties of the given channel. 5b. Determine discharge in the given channel using relevant formulae for the given data 5c. Design the most economical channel section for the given conditions. 5d. Describe the procedure of finding velocity and discharge using the given flow-measuring device. 5e. Measure the velocity of flow through open channel for the given condition.	5.1 Geometrical properties of channel section: Wetted area, wetted perimeter, hydraulic radius for rectangular and trapezoidal channel section. 5.2 Determination of discharge by Chezy's equation and Manning's equation 5.3 Conditions for most economical rectangular and trapezoidal channel section 5.4 Discharge measuring devices: Triangular and rectangular Notches 5.5 Velocity measurement devices: current meter, floats and Pitot tube 5.6 Specific energy diagram, Froude's Number, and Hydraulic.
Unit –VI Hydraulic Pumps	6a. Describe the construction of the hydraulic pump in the given situation with sketches. 6b. Describe the working of the pump used for the given data with sketches. 6c. Describe the different heads of pump in the given situation. 6d. Compute the power of	6.1 Concept of pump, Types of pump-centrifugal, reciprocating pumps, submersible pumps 6.2 Centrifugal pump: Component parts and working 6.3 Reciprocating pump: single acting and double acting, component parts and working. 6.4 Suction head, delivery head, static

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Centrifugal pump from the given data. 6e. Select relevant type of pump for the given situation.	head Manometric head 6.5 Compute power of centrifugal pump. 6.6 Selection and choice of pump

***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	Pressure and pressure measurement	08	4	4	4	12
II	Hydrostatics	08	2	4	4	10
III	Fundamentals of fluid flow	08	2	4	6	12
IV	Flow through pipes	10	2	6	6	14
V	Flow through open channel	10	4	4	6	14
VI	Pumps	04	-	4	4	08
Total		**48**	**14**	**26**	**30**	**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. Library / Internet survey of hydraulic structures.
d. Prepare power point presentation or animation for understanding different principles of hydraulics.
e. Visit nearby natural channel/canal and Submit report consisting flow data, cross sections, hydraulic data for the same.
f. Interpretation and relevance of Moody's chart.
g. Collect the data from YouTube/videos showing various concepts and technologies related to the subject under consideration
h. Interpretation and relevance of Nomogram.

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. Use Flash/Animations to explain various theorems in circuit analysis
g. Demonstrate various concepts used in hydraulics.
h. Encourage the students to refer different websites to have deeper understanding of new concepts and new technologies related to hydraulics.

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. Collect the information of different types of pumps for selection of type of pump.
b. Suggest the relevant type of Pump for typical bungalow/single storey building for the given data.
c. Construct a channel for a given specific discharge.
d. Determine the total head loss for a multistoried building.
e. Measure the discharge of the channel by using triangular notches of different angle.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Hydraulics and Fluid Mechanics	Modi,P. N.and Seth, S.M.	Standard book house, Delhi **ISBN:**13: 978-8189401269;
2	Hydraulics, Fluid Mechanics and Fluid Machines	Ramamrutham, and Narayan, R.	Dhanpat Rai Publishing Company, New Delhi, **ISBN:**8187433841
3	Hydraulics, Fluid Mechanics,	Khurmi,R S	S Chand Publishers, New Delhi

S. No.	Title of Book	Author	Publication
	Hydraulic machines		ISBN: 9788121901628
4	Fluid Mechanics	Rajput, R K	S Chand, New Delhi ISBN: 9788121916677
5	Fluid Mechanics and Machinery	Ojha, C S P, and Berndtsson, R	Oxford University Press, New Delhi, ISBN: 9780195699630

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=5RCeLYbiZCk
b. https://www.youtube.com/watch?v=qGQ4fojjwvQ
c. https://www.youtube.com/watch?v=YrFM51hBQXk
d. https://www.youtube.com/watch?v=JXQxdQt3Zac&list=PL1YauKdEeDpX5ycmkxY7WTLWfBLUV_CLp
e. https://www.youtube.com/watch?v=9DYyGYSUhIc
f. https://www.youtube.com/watch?v=UJ3-Zm1wbIQ
g. https://www.youtube.com/watch?v=H3TcLoapJBo
h. https://www.youtube.com/watch?v=upHHx42r4E0
i. https://www.youtube.com/watch?v=DnHZOFmlQqI
j. https://www.youtube.com/watch?v=7dHmGYGt6Dg
k. https://www.youtube.com/watch?v=4Pyu_YBxYpE
l. https://www.youtube.com/watch?v=BaEHVpKc-1Q
m. https://www.youtube.com/watch?v=s6RIx0SL3C8
n. https://www.youtube.com/watch?v=aGIemvowbPs
o. https://www.youtube.com/watch?v=f_NChxpnc20