GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)
Semester-III

Course Title: Hydraulics
(Course Code: 4330604)

Diploma programme in which this course is offered	Semester in which offered
Civil Engineering, Environmental Engineering	Third

1. RATIONALE

It is necessary for civil, environmental and transportation engineers to understand the behavior of fluid flow in different conditions in pipes, channels, canals, notches, weirs etc. In the field these conditions are very common and diploma pass-outs have to solve problems related to water seepage and discharge.

The basic knowledge about hydraulics and fluid mechanics will be useful in subjects like Irrigation, Water Resources Management and Public Health Engineering. In this course, basics of hydraulics and its application oriented content has been kept with a focus that students should be able to solve practical problems. Competencies developed by this course would therefore be useful for students while performing his/her job in the field of Water resources / Irrigation/PHE and Environment Engineering.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

i. Measure the pressure and flow of water in different conditions using various measuring devices

ii. Compute discharge and loss of head through pipes, open channels, notches and other hydraulic structures.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) To measure pressure and determine total hydrostatic pressure for different conditions.
b) To acquire knowledge of different types of flow, different types of energy, and different types of equation & theory.
c) To determine head loss of fluid flow through pipes.
d) To compute discharge by various formulas in open channels.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA*	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Measure the pressure of water in pipe using (a) Piezometer (b) Different types of manometers	I	04
2	Determine discharge through a given venturimeter.	II	04
3	Determine coefficient such as Cc, Cv, and Cd for different types of orifices	III	04
4	Compute coefficient of discharge for V notch and Preparation of calibration graph for interpolation and extrapolation	IV	04
5	Compute coefficient of discharge for Rectangular notch and Preparation of calibration graph for interpolation and extrapolation	IV	04
6	Determine loss of head in various diameter of pipes and effect of material of pipe on loss of head	III	04
7	Demonstrate functioning of Bernoulli's Apparatus	II	02
8	Demonstrate use of Reynold's number	II	02
		Total	28

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
	For PrOs 2, 5-12, 14 & 15	
1	**Selection of appropriate Apparatus**	10
2	**Perform Standard Experimental Procedure**	30
3	**Observations and calculations**	30
4	**Follow Safety Precautions**	10
5	**Effective participation in practical group**	10
6	**Answer the question and Submission of work**	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practicals in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	● Piezometer	1
2	● U-Tube Manometer	1
3	● Ventutrimeter	2
4	● V-notch	4
5	● Rectangular notch	5
6	● Pipes- PVC, G.I.,	6
7	● Measuring Tank	All
8	● Stop Watch	All
9	● Gauge	All
10	● Hydraulic Bench	All

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a team member/ individual.
b) Follow ethical practices.
c) Follow safe practice on site.
d) Practice of environmental friendly methods and processes.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed

out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Pressure measurement and Hydrostatic pressure	1a. Explain the terms associated with Hydraulics 1b. Clarify different properties of fluid 1c. Describe different types of pressure and methods of measurement 1d. Explain the relationship between pressure and depth of liquid 1e.Compute total Pressure and Centre of pressure	1.1Technical terms used inHydraulics – Fluid Mechanics, Hydrostatics,Hydro-kinematics, Hydro-Dynamics-Ideal and RealFluid. 1.2Properties of liquid – Viscosity-Density-Specific Gravity-Surface Tension-Capillarity Vapour Pressure-Elasticity. 1.3Various types of pressure – Atmospheric Pressure- Gauge Pressure-Absolute Pressure Vacuum Pressure-Separation Pressure/s. 1.4Measurement of pressure/s by different methods 1.5Measurement of difference of pressure using “U”tube Manometer and inverted “U” tube Manometer 1.6Relationship between pressure and depth of liquid 1.6.1Pressure diagram for different conditions 1.7Total pressure and center of pressure 1.7.1 Computation of Total Pressure and depth of the center of pressure
Unit- II Hydro kinematics & Hydrodynamics	2a. Derive Continuity Equation 2b. Explain different types of flow 2c. Explain different kinds of energy 2d Apply Bernoulli’s theorem to measurethe pressure and Discharge.	2.1 Discharge & its units, Continuity Equation 2.2 Types of flow - Laminar --Turbulent --Uniform -- Non-uniform –Steady--Un-steady –Rotational and irrotational --One, Two and Three Dimensional flow 2.3 Reynold’s number 2.4 Types of Energy – Potential, Pressure, and kinematics 2.5 Bernoulli’s theorem: statement, assumptions, derivation & limitations. 2.6 Practical application of Bernoulli”s theorem

Unit- III **Flow through pipes**	3a. Explain Head losses 3b. Draw Hydraulic Gradient Line (HGL) and Total Energy Line (TEL) 3c. Computation of diameter of the equivalent pipe. 3d. Compute different Hydraulic Coefficients for different types of orifice	3.1Characteristics of flow through pipes 3.2 Major Head losses in pipe: Computation by Darcy's Weisbach equation, Use of Chezy's & Manning's formula, Nomograms 3.3Computation of minor head losses in a pipe. 3.4 Hydraulic Gradient Line (HGL) and Total Energy Line (TEL) 3.5 Flow through pipes in series (Compound Pipe), pipes in parallel. 3.6 Equivalent Pipe 3.7Discharge measurement using orifice 3.8 Various Hydraulic Coefficient and its relation
Unit- IV **Flow through Open Channel**	4a.Explain Geometrical properties of channel section 4b.Compute discharge through Notches and Weir with various formula. 4c. Explain conditions for most economical section	4.1Definition and classification of channel 4.2 Geometrical properties of channel section: Wetted area, wetted perimeter, hydraulic radius, hydraulic mean depth for rectangular and trapezoidal channel section, Froud's number, 4.3Determination of discharge by Chezy's equation and Manning's equation, Bazin's equation, and Kutter's equation. (Without derivation) 4.4Conditions for the most economical section: rectangular, Trapezoidal, and circular section of open channel. 4.5 Discharge measuring devices: Triangular and rectangular Notches. 4.6 Computation of discharge through different types of weir: Narrow, Broad, Sharp crested weir; Cippoletti weir and Ogee weir. 4.6 Specific energy diagram, Hydraulic jump 4.7 River gauging & measurement of mean velocity.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Pressure measurement and Hydrostatic pressure	10	4	8	4	16
II	Hydro kinematics & Hydrodynamics	08	2	6	6	14
III	Flow through pipes	12	4	8	8	20
IV	Flow through Open Channel	12	4	8	8	20
Total		**42**	**14**	**30**	**26**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly 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:

Following is the list of proposed student activities like:

1.Student will visit nearby Canal Structure and Submit report consisting flow data, cross sections, hydraulic data etc. for the same.

2.Student will Survey an industry / Department for handling or using pressure measuring devices.

3.Student will carry out market survey for pipes of different materials.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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) Guide student(s) in undertaking micro-projects.
c) Use demonstration, video/animation films field/industry visit for explaining complex/abstract concepts of Hydraulics.
d) This course requires lot of practice on numerical. Students may be asked to solve the numerical during lecture periods and tutorial periods, in addition home

assignments may be given. To avoid copying by students each problem must have different parameters for each student or at least there may be five to six sets of problems with different values., In other words each student will get same problem but with varied parameters. (Values of pressure, volume, flow, force, distance, speed etc may be different for each student)

e) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.

f) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.

g) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

h) Guide students on how to address issues on environment and sustainability

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 she/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 is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Market Survey and comparison of different pipe material.

b) Case study and collection of different hydraulic parameters of open channel.

c) Develop practical to find out types of flow(Critical flow, Subcritical flow and Supercritical flow) based on Froude Number.

d) Determine loss of head of any single building in your campus.

e) Find out number of weirs and collect the different hydraulic parameters within state/district using Internet sources.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN

1	Hydraulics, Fluid Mechanics and Hydraulic machine	S.Ramamrutham	Dhanpat Rai
2	Hydraulics, Fluid Mechanics and Hydraulic machine	R. S. Khurmi	S.Chand
3	Hydraulics, Fluid Mechanics and Hydraulic machine	R K Bansal	S.Chand
4	Fluid Mechanics	A K Jain	Khanna Publishers
5	Journal of experiments in Hydraulics	Rao and Hasan	New Height
6	Hydraulic laboratory	Rao and Hasan	New Height
7	Fluid Mechanics	Dr.M.L.Mathur	Std.Publication
8	Fluid Mechanics & Hydraulics	S.C.Gupta	Pearson Education
9	Hydraulics and Hydraulic machine	Prof.V.P.Priyani	Charotar Publication
10	Hydraulics, Fluid Mechanics and Hydraulic machine	S.Ramamrutham	Dhanpat Rai

14. SOFTWARE/LEARNING WEBSITES (From Old Syllabus)

a) www.nptel.iitm.ac.in
b) www.waterbouw.tudelft.nl/
c) www.learnrstv.com
d) www.shiksha.com ,IIT, Roorkee
e) www.blackwellpublishing.com
f) www.hrpwa.org
g) www.creativeworld9.com

15. PO-COMPETENCY-CO MAPPING

Semester II	Civil Engineering Drawing (Course Code:4320601)									
	POs and PSOs									
Competency & Course Outcomes	**PO 1** Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design/ development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning	**PSO 1**	**PSO 2**	**PSO 3** (If needed)
Competency	i. Read and interpret the building construction drawings. ii. Produce working and /or submission drawings for simple civil engineering structures with building services as per regulations and bye-laws considering green building aspects.									
Course Outcomes CO a) To Measure pressure and determine total hydrostatic pressure for different conditions.	3	2	2	3	-	-	2	-	-	-
CO b) To acquire knowledge of different types of flow, different types of energy, and different types of equation & theory.	3	2	-	2	-	-	2	-	-	-
CO c) To Determine head loss of fluid flow through pipes.	3	2	2	2	2	-	2	-	-	-

CO d) To Compute discharge by various formulas in open channels.	3	2	1	2	2	-	2	-	-	-

Legend: '**3**' for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Shri Dipesh H. Dalal Lecturer in Civil Engg.	Govt.Poly. for Girls',Ahmedabad	079-26301581	dhdalal@gmail.com
2	Smt. VaishaliB. Patel Lecturer in Civil Engg.	Govt.Poly.,Ahmedabad	079-26301285	vaishali.civil@gmail.com
3	Dr. A.K.Patel	Govt.Poly.,Ahmedabad	9825009719	Ashutech.asp@gmail.com