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HYDRAULICS **Course Code : 314303**

Programme Name/s	**: Agricultural Engineering/ Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering**
Programme Code	**: AL/ CE/ CR/ CS/ LE**
Semester	**: Fourth**
Course Title	**: HYDRAULICS**
Course Code	**: 314303**

I. RATIONALE

Hydraulics is a course of civil engineering which consists of study of fluid behavior and design of hydraulic structures. The study of hydraulics plays a important role in various civil engineering applications such as water supply, wastewater management, drainage systems and hydraulic structures. Understanding hydraulics for civil engineers will help them to make decisions during design of hydraulic structures and ensuring the efficient management of water supply and wastewater sources. In this course, student will learn behavior of fluid at rest, fluid in motion, flow through open channel and flow through pipe.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

• Apply the principles of hydraulics in given situation to solve the civil engineering problem.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the pressure parameters obtained from pressure measuring devices in liquids.
- CO2 - Determine total hydrostatic pressure and center of pressure for different conditions.
- CO3 - Calculate relevant parameters for given fluid flow.
- CO4 - Determine loss of head for flow through pipe in given situation.
- CO5 - Find the relevant fluid flow parameters in open channels.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314303	HYDRAULICS	HYD	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the role of hydraulics in the given civil engineering application. TLO 1.2 Compute different properties of liquid from given data. TLO 1.3 Convert gauge pressure into absolute pressure for the given data and vice-versa. TLO 1.4 Compute pressure at a point and pressure difference between two points for the given data using appropriate device.	**Unit - I Pressure Measurement** 1.1 Technical terms used: Fluid, Fluid Mechanics, Hydraulics, Hydrostatics, and hydrodynamics-Ideal and Real Fluid, Application of hydraulics in Civil Engineering field. 1.2 Physical properties of fluid : Mass Density, Weight Density, Specific Volume, Specific Gravity, Surface Tension of Water, Capillarity of Water, Viscosity, Units of Viscosity, Kinematic Viscosity, Newton’s law of Viscosity. 1.3 Various types of pressure: Fluid Pressure, Pressure Head, Pasacl’s Law and its applications, Absolute Pressure, Gauge Pressure, Atmospheric Pressure, Vacuum Pressure. 1.4 Pressure Measuring Devices: Piezometer, Simple U tube Manometer, U Tube Differential Manometer and Inverted U Tube Differential Manometer, Bourdon Tube Pressure Gauge.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on Site/Industry Visit Case Study
2	TLO 2.1 Determine the variation of pressure with depth for the given fluid. TLO 2.2 Find Total Pressure and Centre of Pressure for given immersed surface. TLO 2.3 Calculate the resultant pressure and its position using pressure diagram.	**Unit - II Hydrostatics** 2.1 Definition of Hydrostatics, Total Pressure and Centre of Pressure :Concept and Applications. 2.2 Total Hydrostatic Pressure and Center of Pressure :on:Horizontally, Vertically Immersed Surfaces: for rectangular, Triangular and Circular lamina. 2.3 Total Pressure and Center of Pressure using Pressure diagram on sides , bottom and partition wall of a tank .	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Identify the type of flow using the concept of Reynold Number. TLO 3.2 Calculate discharge and velocity in the given situation using Continuity Equation. TLO 3.3 Calculate Total Energy of the given fluid flow. TLO 3.4 Apply Bernoulli's Theorem in the given situation to calculate losses and direction of flow.	**Unit - III Hydro kinematics and Hydro dynamics** 3.1 Types of Fluid Flow: Steady, unsteady, uniform, non uniform, laminar, turbulent, compressible and incompressible flow, Reynold's number. 3.2 Discharge: Definition, Unit, Continuity Equation. 3.3 Energies associated with fluid flow: Potential, Kinetic, Pressure Energy and total energy. 3.4 Bernoulli's Equation: Statement, Assumptions, Equation, Practical applications , Modified Bernoulli's Theorem.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on
4	TLO 4.1 Apply the Darcy Weisbach equation to calculate the relevant losses in a pipe flow. TLO 4.2 Calculate minor losses from the given data. TLO 4.3 Calculate Discharge of pipe system(in Parallel and in series) and Design equivalent pipe. TLO 4.4 Draw HGL and TEL from the given data. TLO 4.5 Calculate discharge in a pipe for the given data using venturimeter. TLO 4.6 Calculate coefficients of Orifice Cd, Cc, Cv for given data . TLO 4.7 Suggest the type of pump for given situation. TLO 4.8 Describe the working of the centrifugal pump with sketch. TLO 4.9 Describe the different types of heads associated with Centrifugal pump. TLO 4.10 Compute the power required for Centrifugal pump from the given data.	**Unit - IV Flow through Pipes And Pumps** 4.1 Major head loss in pipe: Frictional loss and its computation by Darcy Weisbach equation. (Simple Numericals on Darcy Weisbach equation) 4.2 Minor Energy (Head) losses in pipe: Sudden Enlargement, Sudden Contraction, loss of head at entrance of pipe, loss of head at exit of pipe, loss of head due to bend in pipes 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(No Numerical, only representative Diagram). 4.5 Discharge measuring device for pipe flow: Venturimeter, Construction and working. 4.6 Discharge measuring for a tank: using Orifice, Hydraulic Coefficients of Orifice. 4.7 Pump: Types of pump :Centrifugal, Reciprocating pumps and Submersible pumps. 4.8 Centrifugal pump: Component parts and working. 4.9 Types of heads :Suction head, delivery head, static head and Manometric head. 4.10 Compute power requirement of Centrifugal Pump.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on Site/Industry Visit

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe the geometrical properties of the given Channel. TLO 5.2 Determine discharge in the given channel using relevant formulae for the given data. TLO 5.3 Design the most economical channel section for the given conditions. TLO 5.4 Describe the procedure of finding velocity and discharge using the given flow measuring device. TLO 5.5 Measure the velocity of flow through open channel for the given condition.	**Unit - V Flow through Open Channel** 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: 'V' Notches and Rectangular Notches. 5.5 Velocity measurement devices: Floats, Pitot tube.	Model Demonstration Video Demonstrations Demonstration Presentations Lecture Using Chalk-Board Hands-on Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Determine physical parameters of given sample of tap water and muddy water.	1	*Computation of physical properties of given fluid (tap water and muddy water).	2	CO1
LLO 2.1 Determine the physical properties of given sample of oil and Mercury.	2	Computation of physical properties of given liquid (oil and Mercury).	2	CO1
LLO 3.1 Measure the pressure at a given point using Bourdon Gauge.	3	Use of Bourdon Gauge to measure the pressure at a given point.	2	CO1
LLO 4.1 Measure the pressure difference between two given points using U tube differential manometer.	4	*Use of U tube differential manometer to measure the pressure difference between two given points.	2	CO1
LLO 5.1 Calculate the resultant pressure and its position for given situation of liquid in a tank.	5	*Find the resultant pressure and its position for given situation of liquid in a tank.	2	CO2
LLO 6.1 Interpret type of flow based on computed value of Reynold's number.	6	Use of Reynold's apparatus to determine type of flow.	2	CO3
LLO 7.1 Apply Bernoulli's theorem the given situation to obtain Total Energy Line.	7	*Use of Bernoulli's apparatus to obtain Total Energy Line for flow in closed conduit of varying cross sections.	2	CO3
LLO 8.1 Determine friction factor for the given pipe using Friction factor Apparatus.	8	*Use of Friction factor Apparatus to determine the friction factor for the given pipe.	2	CO4
LLO 9.1 Determine minor losses in pipe fittings (sudden contraction and Sudden enlargement).	9	*Determination of minor losses in pipe for sudden contraction and sudden enlargement.	2	CO4
LLO 10.1 Calculate minor losses in pipe fitting (Bend and Elbow).	10	Determination of minor losses in pipe fitting such as Bend and Elbow.	2	CO4
LLO 11.1 Determine the Coefficient of discharge for the given venturimeter fitted in pipe section.	11	*Calibration of Venturimeter to find out the discharge in a pipe.	2	CO4
LLO 12.1 Calculate Cd, Cc and Cv for given type of Orifice.	12	Calibration of Orifice to find out the discharge through a tank.	2	CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Calculate the efficiency of given Centrifugal Pump.	13	*Determination of efficiency of given Centrifugal Pump.	2	CO4
LLO 14.1 Determine the Coefficient of discharge for given 'V' notch fitted to open channel.	14	*Use of 'V' notch to measure the discharge through open channel.	2	CO5
LLO 15.1 Determine the Coefficient of discharge for flow through open channel using rectangular notch.	15	Use of rectangular notch to measure the discharge through open channel.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Collect the technical brochure of available brands of pump in the market and prepare report with your comments.

Determination of type and capacity of pump for residential bungalow (06 Occupants) of G+1 Storey having 200 Sq m built up area.
Prepare a model of rectangular and trapezoidal channel.

Assignment

- State and explain causes and remedial measures of water hammer.

Explain the necessity of hydraulic jump.
Explain with neat sketch working of single acting and double acting reciprocating pump.
Explain critical, sub critical and supercritical flow with reference to Froude's number.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Measuring cylinder, Weighing balance	1,2
2	Pipe setup, bend, elbow fittings, stop watch	10
3	Pipe set up fitted with Venturimeter, U tube differential manometer, Stop watch	11
4	Centrifugal pump set up	13
5	Channel set up with different notches, Stop watch	14,15
6	U tube differential manometer, Mercury	2,4
7	Bourdon tube pressure gauge	3

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
8	Reynold's apparatus, colour dye, Stop watch	6
9	Bernoulli's apparatus, Stop watch	7
10	Friction factor Apparatus, Stop watch	8
11	Apparatus for finding minor losses in the pipe, Stop watch	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Pressure Measurement	CO1	12	2	8	4	14
2	II	Hydrostatics	CO2	12	2	8	4	14
3	III	Hydro kinematics and Hydro dynamics	CO3	10	2	4	6	12
4	IV	Flow through Pipes And Pumps	CO4	16	4	10	6	20
5	V	Flow through Open Channel	CO5	10	4	0	6	10
Grand Total				**60**	**14**	**30**	**26**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work ,Assignment, Microproject (60% Weightage to process and 40% weightage to product),Question and Answer

Summative Assessment (Assessment of Learning)

- Pen and PaperTest (WrittenTest),Practical Exam ,Oral Exam

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	3	3	2	3	2	2			
CO2	2	2	3	2	2	2	2			
CO3	2	2	3	3	2	2	2			
CO4	2	2	2	2	2	2	2			
CO5	2	3	2	1	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Modi, P. N. and Seth, S.M.	Hydraulics and Fluid Mechanics	Standard book house, Delhi ISBN:13: 978-8189401269;

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Sr.No	Author	Title	Publisher with ISBN Number
2	Ramamrutham S, and Narayan, R.	Hydraulics, Fluid Mechanics and Fluid Machines	Dhanpat Rai Publishing Company, New Delhi, ISBN:8187433841
3	Khurmi, R S	Hydraulics, Fluid Mechanics, Hydraulic machines	S Chand Publishers, New Delhi ISBN: 9788121901628
4	Rajput, R K	Fluid Mechanics	S Chand, New Delhi ISBN: 9788121916677
5	Dr. R.K. Bansal	Fluid mechanics and hydraulic machines	Laxmi Publication; New Delhi, ISBN: 978-8131808153

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://eerc03-iiith.vlabs.ac.in/	An MoE, Govt of India virtual laboratory of Hydraulics and Fluid Mechanics.
2	https://nptel.ac.in/courses/105105203	Basics of Fluid Mechanics
3	https://archive.nptel.ac.in/courses/105/106/105106114/	Classification of flow
4	https://nptel.ac.in/courses/105103021	Open Channel flow
5	http://www.nitttrc.edu.in/nptel/courses/video/105101082/L01.html	Fluid Properties
6	https://onlinecourses.nptel.ac.in/noc24_ce20/preview	Hydraulic Jump
7	http://www.nitttrc.edu.in/nptel/courses/video/105103021/L01.html	Advanced Hydraulics
8	https://www.youtube.com/watch?v=mIF7nQBbaj0&list=UU__JX7j7HYXROO6jCAUmHIw&index=231	Fluid Pressure
9	https://www.youtube.com/watch?v=-jb5A9GIuNQ	Energy Gradient of pipe flow
10	https://www.youtube.com/watch?v=qie6UCJqM_Q	Bernoulli’s Equation
11	https://www.youtube.com/watch?v=PH75Y1wIubQ	Hydraulic Pumps

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students