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|-------------------------|---|
| 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 | | | | | | | | | | | | Total Marks |
|-------------|--------------|------|-------------------|--------------------------|----|----|----|---|---------|-------------------|----------------|--------|-------|-------|----|------------------|-----|-------|-----|-------------|-----|-------------|
| | | | | Actual Contact Hrs./Week | | | SL | H | | NL | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | |
| | | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | | | | | | 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 | |

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 | <p>TLO 1.1 Describe the role of hydraulics in the given civil engineering application.</p> <p>TLO 1.2 Compute different properties of liquid from given data.</p> <p>TLO 1.3 Convert gauge pressure into absolute pressure for the given data and vice-versa.</p> <p>TLO 1.4 Compute pressure at a point and pressure difference between two points for the given data using appropriate device.</p> | <p>Unit - I Pressure Measurement</p> <p>1.1 Technical terms used: Fluid, Fluid Mechanics, Hydraulics, Hydrostatics, and hydrodynamics-Ideal and Real Fluid, Application of hydraulics in Civil Engineering field.</p> <p>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.</p> <p>1.3 Various types of pressure: Fluid Pressure, Pressure Head, Pascal's Law and its applications, Absolute Pressure, Gauge Pressure, Atmospheric Pressure, Vacuum Pressure.</p> <p>1.4 Pressure Measuring Devices: Piezometer, Simple U tube Manometer, U Tube Differential Manometer and Inverted U Tube Differential Manometer, Bourdon Tube Pressure Gauge.</p> | <p>Model</p> <p>Demonstration</p> <p>Video</p> <p>Demonstrations</p> <p>Demonstration</p> <p>Presentations</p> <p>Lecture Using</p> <p>Chalk-Board</p> <p>Hands-on</p> <p>Site/Industry Visit</p> <p>Case Study</p> |

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|-------|---|---|--|
| 2 | <p>TLO 2.1 Determine the variation of pressure with depth for the given fluid.</p> <p>TLO 2.2 Find Total Pressure and Centre of Pressure for given immersed surface.</p> <p>TLO 2.3 Calculate the resultant pressure and its position using pressure diagram.</p> | <p>Unit - II Hydrostatics</p> <p>2.1 Definition of Hydrostatics, Total Pressure and Centre of Pressure :Concept and Applications.</p> <p>2.2 Total Hydrostatic Pressure and Center of Pressure :on:Horizontally, Vertically Immersed Surfaces: for rectangular, Triangular and Circular lamina.</p> <p>2.3 Total Pressure and Center of Pressure using Pressure diagram on sides , bottom and partition wall of a tank .</p> | <p>Model</p> <p>Demonstration</p> <p>Video</p> <p>Demonstrations</p> <p>Demonstration</p> <p>Presentations</p> <p>Lecture Using</p> <p>Chalk-Board</p> <p>Hands-on</p> |
| 3 | <p>TLO 3.1 Identify the type of flow using the concept of Reynold Number.</p> <p>TLO 3.2 Calculate discharge and velocity in the given situation using Continuity Equation.</p> <p>TLO 3.3 Calculate Total Energy of the given fluid flow.</p> <p>TLO 3.4 Apply Bernoulli's Theorem in the given situation to calculate losses and direction of flow.</p> | <p>Unit - III Hydro kinematics and Hydro dynamics</p> <p>3.1 Types of Fluid Flow: Steady, unsteady, uniform, non uniform, laminar, turbulent, compressible and incompressible flow, Reynold's number.</p> <p>3.2 Discharge: Definition, Unit, Continuity Equation.</p> <p>3.3 Energies associated with fluid flow: Potential, Kinetic, Pressure Energy and total energy.</p> <p>3.4 Bernoulli's Equation: Statement, Assumptions, Equation, Practical applications , Modified Bernoulli's Theorem.</p> | <p>Model</p> <p>Demonstration</p> <p>Video</p> <p>Demonstrations</p> <p>Demonstration</p> <p>Presentations</p> <p>Lecture Using</p> <p>Chalk-Board</p> <p>Hands-on</p> |

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|-------|--|--|---|
| 4 | <p>TLO 4.1 Apply the Darcy Weisbach equation to calculate the relevant losses in a pipe flow.</p> <p>TLO 4.2 Calculate minor losses from the given data.</p> <p>TLO 4.3 Calculate Discharge of pipe system(in Parallel and in series) and Design equivalent pipe.</p> <p>TLO 4.4 Draw HGL and TEL from the given data.</p> <p>TLO 4.5 Calculate discharge in a pipe for the given data using venturimeter.</p> <p>TLO 4.6 Calculate coefficients of Orifice Cd, Cc, Cv for given data.</p> <p>TLO 4.7 Suggest the type of pump for given situation.</p> <p>TLO 4.8 Describe the working of the centrifugal pump with sketch.</p> <p>TLO 4.9 Describe the different types of heads associated with Centrifugal pump.</p> <p>TLO 4.10 Compute the power required for Centrifugal pump from the given data.</p> | <p>Unit - IV Flow through Pipes And Pumps</p> <p>4.1 Major head loss in pipe: Frictional loss and its computation by Darcy Weisbach equation. (Simple Numericals on Darcy Weisbach equation)</p> <p>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.</p> <p>4.3 Flow through pipes in series, pipes in parallel and Dupit's equation for equivalent pipe.</p> <p>4.4 Hydraulic Gradient Line and Total Energy Line(No Numerical, only representative Diagram).</p> <p>4.5 Discharge measuring device for pipe flow: Venturimeter, Construction and working.</p> <p>4.6 Discharge measuring for a tank: using Orifice, Hydraulic Coefficients of Orifice.</p> <p>4.7 Pump: Types of pump :Centrifugal, Reciprocating pumps and Submersible pumps.</p> <p>4.8 Centrifugal pump: Component parts and working.</p> <p>4.9 Types of heads :Suction head, delivery head, static head and Manometric head.</p> <p>4.10 Compute power requirement of Centrifugal Pump.</p> | <p>Model</p> <p>Demonstration</p> <p>Video</p> <p>Demonstrations</p> <p>Demonstration</p> <p>Presentations</p> <p>Lecture Using</p> <p>Chalk-Board</p> <p>Hands-on</p> <p>Site/Industry Visit</p> |
| 5 | <p>TLO 5.1 Describe the geometrical properties of the given Channel.</p> <p>TLO 5.2 Determine discharge in the given channel using relevant formulae for the given data.</p> <p>TLO 5.3 Design the most economical channel section for the given conditions.</p> <p>TLO 5.4 Describe the procedure of finding velocity and discharge using the given flow measuring device.</p> <p>TLO 5.5 Measure the velocity of flow through open channel for the given condition.</p> | <p>Unit - V Flow through Open Channel</p> <p>5.1 Geometrical properties of Channel section: Wetted area, Wetted perimeter, Hydraulic Radius for Rectangular and Trapezoidal Channel section.</p> <p>5.2 Determination of discharge by Chezy's equation and Manning's equation.</p> <p>5.3 Conditions for most economical rectangular and trapezoidal channel section.</p> <p>5.4 Discharge Measuring Devices: 'V' Notches and Rectangular Notches.</p> <p>5.5 Velocity measurement devices: Floats, Pitot tube.</p> | <p>Model</p> <p>Demonstration</p> <p>Video</p> <p>Demonstrations</p> <p>Demonstration</p> <p>Presentations</p> <p>Lecture Using</p> <p>Chalk-Board</p> <p>Hands-on</p> <p>Site/Industry Visit</p> |

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

HYDRAULICS**Course Code : 314303**

| 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 |
| 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 judicious 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 |
| 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)

HYDRAULICS**Course Code : 314303**

| 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; |
| 2 | Ramamrutham S, and Narayan, R. | Hydraulics, Fluid Mechanics and Fluid Machines | Dhanpat Rai Publishing Company, New Delhi, ISBN:8187433841 |

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| Sr.No | Author | Title | Publisher with ISBN Number |
|-------|-----------------|---|--|
| 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__JX7j7HYXRO06jCAUmHIw&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