

GUJARAT TECHNOLOGICAL UNIVERSITY

3 SEMESTER – OLD PAPER – SUMMER 2022 TO SUMMER 2026 – QUESTION BANK

Subject Name & Code: Basics of Environmental Hydraulics - 3131307

Chapter 1: Properties of Fluid

Repeated Questions:

1. Definitions of Fluid Properties:

- **Q.** Define the following terms: (i) Specific Gravity (ii) Capillarity (iii) Mass density / Viscosity / Surface tension / etc. **(WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 3 Marks; SUMMER 2026, 3 Marks)**

2. Viscosity:

- **Q.** Explain the effect of temperature on the viscosity of liquids and gases. **(SUMMER 2022, 4 Marks; SUMMER 2023, 4 Marks; WINTER 2025, 4 Marks)**
- **Q.** Distinguish dynamic viscosity and kinematic viscosity. State their unit. / Explain the term viscosity and differentiate between Kinematic viscosity and Dynamic viscosity. **(WINTER 2022, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2026, 4 Marks)**

3. Types of Fluids:

- **Q.** Explain the different types of fluids with figure. **(SUMMER 2022, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 7 Marks; WINTER 2025, 7 Marks OR)**

Other Important Questions:

1. Theory – Surface Tension, Cohesion and Adhesion:

- **Q.** Explain surface tension and prove the relationship between surface tension and pressure for liquid droplet. **(WINTER 2023, 4 Marks)**
- **Q.** Explain the concept of surface tension with figure. Derive the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure. **(WINTER 2025, 7 Marks)**
- **Q.** Differentiate between: cohesion and adhesion. **(SUMMER 2025, 3 Marks)**

2. Numericals – Viscosity, Velocity Gradient and Shear Stress:

- **Q.** If the velocity profile of a fluid over a plate is parabolic with vertex 20 cm from the plate, where the velocity is 120 cm/s. Calculate the velocity gradients and shear stress at a distance of 0, 10, 20 cm from the plate, if the viscosity of the fluid is 8.5 poise. **(SUMMER 2023, 7 Marks)**
- **Q.** A flat plate 30 cm × 50 cm slides on oil ($\mu = 0.8 \text{ Ns/m}^2$) over a large plane surface. What is the force required to drag the plate at 2 m/s if separating oil film is 0.4 mm thick? **(WINTER 2022, 4 Marks)**

3. Numericals – Specific Weight, Mass Density and Specific Gravity:

- **Q.** The weight of 5 m³ of a certain oil is 45 kN. Calculate its specific weight, mass density and specific gravity. **(SUMMER 2022, 4 Marks)**
- **Q.** A reservoir of carbon tetrachloride has a mass of 600 kg and volume of 0.35 m³. Find weight, mass density, specific weight and relative density. **(SUMMER 2025, 7 Marks OR)**

Chapter 2: Hydrostatics

Repeated Questions:

1. Pressure Measurement (Piezometer and Manometers):

- **Q.** Explain piezometer with simple sketch. / With a neat sketch explain piezometer. (**SUMMER 2022, 3 Marks; WINTER 2025, 4 Marks**)
- **Q.** With a neat sketch explain the U-tube manometer. / Explain the differential manometer with sketch. / Explain the U-tube differential manometer. (**SUMMER 2023, 4 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2026, 4 Marks**)

2. Pascal's Law:

- **Q.** State and prove the Pascal's law. / State the Pascal's law and prove it. / State and explain Pascal's law. (**WINTER 2022, 7 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks; SUMMER 2025, 4 Marks; SUMMER 2026, 7 Marks OR**)

3. Total Pressure and Centre of Pressure:

- **Q.** Derive an expression for the force exerted on submerged vertical plane surface by the static liquid and locate the position of center of pressure. / Derive an expression for total pressure and center of pressure for vertical plane surface submerged in static liquid. (**SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR; WINTER 2025, 7 Marks**)

Other Important Questions:

1. Theory – Fluid Types, Pressure Terms and Hydrostatic Law:

- **Q.** Explain the different types of fluids. (**WINTER 2022, 4 Marks**)
- **Q.** Define the following terms: (i) Absolute pressure (ii) Gauge pressure (iii) Centre of pressure. (**SUMMER 2023, 3 Marks**)
- **Q.** State and derive Hydrostatic Law. (**WINTER 2025, 7 Marks**)

2. Numericals – Manometers:

- **Q.** A U-tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and is open to the atmosphere. The contact between water and mercury is in the left limb. Determine the pressure of water in the main line, if the difference in level of mercury in the limbs of U-tube is 10 cm and the free surface of mercury is in the level with centre of the pipe. If the pressure of water in pipe line reduced to 9810 N/m^2 , calculate the new difference in the level of mercury. Sketch the arrangements in both cases. [Diagram required – refer to the original question paper] (**SUMMER 2023, 7 Marks**)
- **Q.** A U-tube manometer contains the mercury as manometric liquid. One end of manometer is connected to a pipe in which a fluid of specific gravity 0.8. The level of mercury in right limb is 7 cm above the center of pipe. Calculate pressure of fluid in a pipe when the difference of mercury level in two limbs is 17 cm. [Diagram required – refer to the original question paper] (**WINTER 2023, 4 Marks**)

3. Numericals – Force on Submerged Plane Surface:

- **Q.** A rectangular plate 3 m wide and 4 m long is immersed in water in such a way as (i) horizontally 1 m below the free surface of water (ii) vertically, 3 m side is parallel to the water surface and 1 m below the free surface of water. Find (a) total pressure on the plate (b) position of centre of pressure. (**SUMMER 2025, 7 Marks**)

Chapter 3: Basics of Fluid Kinetics & Dynamics

Repeated Questions:

1. Euler's Equation and Bernoulli's Theorem:

- Q. Derive an expression for Euler's equation of motion. (SUMMER 2022, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks OR)
- Q. Derive an expression for Bernoulli's equation and mention the assumptions. / Illustrate an expression for Bernoulli's equation and mention the assumptions. (SUMMER 2022, 7 Marks OR; WINTER 2022, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2026, 7 Marks)
- Q. State Bernoulli's theorem and write down the assumptions for it. / State Bernoulli's theorem. Also write down assumptions and applications for it. / State Bernoulli's equation of motion. Also mention the assumptions made for such derivation. (SUMMER 2023, 3 Marks OR; SUMMER 2025, 3 Marks; WINTER 2025, 3 Marks)

2. Equation of Continuity:

- Q. Derive an expression for the equation of continuity in a 3D flow in Cartesian co-ordinate system. (SUMMER 2022, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 7 Marks)

3. Energy Lines (EGL and HGL):

- Q. Explain EGL and HGL. / Define Total energy line and Hydraulic gradient line. / Define HGL and TEL. (SUMMER 2022, 3 Marks; WINTER 2022, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 3 Marks; SUMMER 2025, 4 Marks OR)

4. Flow Measuring Devices (Pitot Tube, Orificemeter, Venturimeter):

- Q. Define the term: Pitot tube. / Explain Pitot tube in details. / Write a short note on Pitot tube. (WINTER 2022, 3 Marks; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks)
- Q. Derive an expression for the discharge through an Orificemeter. / Derive the equation of discharge for orifice meter. / Derive an equation of discharge for Orifice meter. (WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks OR; WINTER 2025, 7 Marks OR)
- Q. Derive an expression for rate of flow through Venturimeter. / Illustrate an expression for the discharge through a Venturimeter. / Derive an equation of discharge for Venturimeter. (WINTER 2023, 7 Marks OR; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks)

5. Laminar and Turbulent Flow:

- Q. Define the term Laminar flow and Turbulent flow. / Differentiate between Laminar and Turbulent flow. (SUMMER 2022, 4 Marks OR; WINTER 2022, 3 Marks OR; SUMMER 2026, 3 Marks)

Other Important Questions:

1. Theory – Types of Flow and Flow Lines:

- Q. Define the term Compressible and Incompressible Flow. (SUMMER 2026, 3 Marks)
- Q. Compare steady vs unsteady flow and laminar vs turbulent flow. (SUMMER 2025, 4 Marks)
- Q. Define following terms: (i) steady flow (ii) Laminar flow (iii) Uniform flow. (SUMMER 2023, 3 Marks)
- Q. Define the terms: (i) steady flow (ii) laminar flow (iii) Uniform Flow (iv) one dimensional flow. (WINTER 2025, 4 Marks)
- Q. Explain steady, unsteady, rotational and irrotational flow. (SUMMER 2022, 4 Marks)
- Q. Distinguish between pathlines, stream lines and streak lines. (SUMMER 2022, 3 Marks OR)

2. Theory – Equations of Motion and Flow Meters:

- **Q.** Explain the different equations of motion. **(WINTER 2025, 4 Marks OR)**
- **Q.** State the difference between Venturimeter and Orificemeter. **(SUMMER 2024, 4 Marks)**

3. Numericals – Continuity Equation and Velocity Field:

- **Q.** The following cases represent the two velocity components, determine the third component of velocity such that they satisfy the continuity equation: (i) $u = x^2 + y^2 + z^2$; $v = xy^2 - yz^2 + xy$ (ii) $v = 2y^2$; $w = 2xyz$. **(SUMMER 2023, 4 Marks)**
- **Q.** A fluid flow field is given by $V = x^2y \mathbf{i} + y^2z \mathbf{j} - (2xyz + xyz^2) \mathbf{k}$. Prove that it is a case of possible steady incompressible fluid flow. Calculate the velocity and acceleration at point (2, 1, 3). **(SUMMER 2023, 7 Marks)**
- **Q.** A pipe through which water is flowing is having diameters 20 cm and 10 cm at the cross section 1 and 2 respectively. The velocity of water at section 1 is 4 m/s. Find the velocity head at section 1 and 2 and also rate of discharge. **(SUMMER 2023, 4 Marks OR)**
- **Q.** A pipe is having diameters, 30 cm and 15 cm at the cross sections 1 and 2 respectively, through which water is flowing. The velocity of water at section 1 is given as 6 m/s. Determine the velocity head at section 1 and 2 and also flow rate. **(WINTER 2023, 4 Marks OR)**

4. Numericals – Venturimeter and Pitot Tube:

- **Q.** A horizontal Venturimeter with inlet diameter 150 mm and throat diameter 75 mm is employed to measure the discharge of water. The differential manometer connected to the inlet gives reading of 150 mm of mercury. Determine the rate of flow if the co-efficient of discharge is 0.98. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks)**
- **Q.** A submarine fitted with a Pitot tube moves horizontally in sea. Its axis is 12.5 m below the surface of the water. The Pitot tube fixed in front of the submarine and along its axis is connected to the two limbs of a U-tube containing mercury, the reading of which is found to be 201 mm. Find the speed of the submarine. Take the specific gravity of sea water = 1.025 times fresh water. [Diagram required – refer to the original question paper] **(WINTER 2024, 4 Marks)**

Chapter 4: Flow Through Pipes

Repeated Questions:

1. Major Loss – Darcy-Weisbach Equation:

- **Q.** Derive Darcy-Weisbach equation for loss of head due to friction in a pipe line. (SUMMER 2022, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks OR; SUMMER 2026, 7 Marks)

2. Energy Losses in Pipes:

- **Q.** Classify various energy (major loss and minor) losses in pipe. / Explain losses of energy in pipe. / Explain the minor energy losses in pipe. / Enlist the minor energy losses. (SUMMER 2022, 3 Marks; SUMMER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks OR; WINTER 2025, 3 Marks; WINTER 2025, 3 Marks OR)

3. Minor Losses – Sudden Enlargement and Sudden Contraction:

- **Q.** List the minor losses and derive formula for calculating loss of head due to sudden enlargement. / Derive an equation of loss of head due to sudden enlargement. (WINTER 2022, 4 Marks OR; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks; WINTER 2025, 7 Marks - appeared twice in SUMMER 2023 paper)
- **Q.** List the minor losses and derive formula for calculating loss of head due to sudden contraction. / Derive an expression for loss of head due to sudden contraction. (WINTER 2022, 7 Marks OR; SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR; WINTER 2024, 7 Marks; SUMMER 2026, 7 Marks OR)

4. Pipes in Series, Parallel and Compound Arrangements:

- **Q.** Write a short note on (i) flow through pipes in series (ii) flow through parallel pipes. / Explain flow through parallel pipes. / Write short note on flow through pipes in parallel. (SUMMER 2023, 7 Marks OR; SUMMER 2024, 4 Marks; WINTER 2025, 4 Marks OR)

5. Pipe Flow vs Open Channel Flow:

- **Q.** Differentiate between open channel and pipe flow. (WINTER 2023, 4 Marks; SUMMER 2025, 3 Marks)

Other Important Questions:

1. Theory – Chezy's Formula:

- **Q.** Derive Chezy's formula for calculating loss of head due to friction in pipe. (WINTER 2022, 7 Marks)
- **Q.** Derive a Darcy-Weisbach equation for head loss due to friction in pipe and also derive Chezy's formula from that. (WINTER 2023, 7 Marks)
- **Q.** Explain the Chezy's formula for loss of head due to friction in pipe. (WINTER 2025, 4 Marks)

2. Theory – Compound Pipes:

- **Q.** Write short note on pipes in compound pipes. (WINTER 2024, 4 Marks)

3. Numericals – Chezy's Formula (Diameter of Pipe):

- **Q.** Find the diameter of a pipe of length 2000 m when the rate of flow of water through the pipe is 200 lit/s, head loss due to friction is 4 m. Take the value of $C = 50$ in Chezy's formula. (WINTER 2022, 4 Marks OR)
- **Q.** Determine the diameter of a pipe of length 2550 m when the rate of flow of water through the pipe is 230 lit/s and the head loss due to friction is 6 m. Take the value of $C = 60$ in Chezy's formula. (WINTER 2024, 4 Marks OR)
- **Q.** Calculate the diameter of pipe of length 2500 m when the rate of flow of water through the pipe is 225 liter/sec and the head lost due to friction is 5 m. Take the value of $C = 60$ in Chezy's formula. (SUMMER 2026, 4 Marks OR)

4. Numericals – Head Loss due to Friction (Darcy-Weisbach):

- **Q.** An oil of kinematic viscosity 0.6 stoke is flowing through a pipe of 31 cm diameter at a rate of 321 liter per second. Find the head loss due to friction for the pipe length of 60 m. **(WINTER 2024, 4 Marks)**
- **Q.** An oil of viscosity 0.5 stokes is flowing through a pipe of 30 cm diameter at a rate of 320 liter per second. Calculate the head loss due to friction for the pipe length of 60 m. **(SUMMER 2026, 4 Marks)**

5. Numericals – Minor Losses and Taper Pipe:

- **Q.** The water is flowing through a taper pipe of length 110 m having diameters 500 mm at the upper end and 250 mm at the lower end at the rate of 60 liters/s. The pipe has a slope of 1 in 50. Determine the pressure at the lower end if the pressure at the higher level is 70 kN/m². **(SUMMER 2022, 3 Marks OR)**
- **Q.** A horizontal pipe 150 mm in diameter, is jointed by sudden enlargement to a 200 mm diameter pipe. Water is flowing through it at a rate of 3 m³/min. Find the loss of head due to sudden enlargement. **(SUMMER 2026, 4 Marks)**
- **Q.** A pipe carries water at 50 liters per second. If the pipe of 200 mm diameter reduces in diameter abruptly to 150 mm diameter, find the pressure loss across the contraction. Take the coefficient of contraction as 0.62. **(SUMMER 2026, 4 Marks OR)**

Chapter 5: Flow through orifice and Mouthpiece

Repeated Questions:

1. Hydraulic Coefficients and Classification of Orifices and Mouthpieces:

- **Q.** Define Co-efficient of Discharge and Co-efficient of Velocity. / Give the classification of orifices. / Define all hydraulic co-efficient. / Explain the term: Coefficient of velocity, Coefficient of contraction, Coefficient of discharge. / Give classification of orifices and mouthpieces. / Give detail classification of mouthpiece. (SUMMER 2022, 3 Marks; SUMMER 2022, 3 Marks; WINTER 2022, 3 Marks; WINTER 2022, 3 Marks OR; SUMMER 2023, 3 Marks; SUMMER 2023, 3 Marks OR; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks; SUMMER 2024, 3 Marks OR; WINTER 2024, 3 Marks; WINTER 2024, 3 Marks OR; SUMMER 2025, 4 Marks OR; WINTER 2025, 3 Marks; WINTER 2025, 3 Marks OR; SUMMER 2026, 3 Marks; SUMMER 2026, 3 Marks OR)
- **Q.** Derive an equation of coefficient of velocity (C_v) and co-efficient of vena contracta. (SUMMER 2023, 4 Marks)

2. Vena Contracta:

- **Q.** Explain vena contracta and how does it occur? / Define vena contracta and co-efficient of contraction. / Explain the term vena contracta. / Explain small orifice and vena contracta. (WINTER 2022, 3 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks OR; WINTER 2024, 3 Marks OR; SUMMER 2025, 4 Marks)

3. Time of Emptying a Tank:

- **Q.** Derive an expression for time of emptying a tank through an orifice of circular horizontal tank. / Derive an equation for time of emptying a hemispherical tank. / Derive an expression for time of emptying a tank through an orifice of rectangular tank. (SUMMER 2023, 7 Marks; SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks; WINTER 2024, 7 Marks OR; SUMMER 2026, 7 Marks; SUMMER 2026, 7 Marks OR)

4. Large Orifice:

- **Q.** Derive an expression for discharge through a large rectangular orifice. / Derive an expression for the discharge through a large orifice. (SUMMER 2022, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2025, 7 Marks OR)

Other Important Questions:

1. Numericals – Orifices:

- **Q.** Find the discharge through a totally drowned orifice 2.0 m wide and 1 m deep, if the difference of water levels on both the sides of the orifice be 3 m. Take $C_d = 0.62$. (WINTER 2022, 4 Marks)
- **Q.** Water flows at the rate of $0.016 \text{ m}^3/\text{s}$ through a 101 mm diameter orifice used in a 201 mm pipe. What is the difference in pressure head between the upstream section and vena contracta section? Take co-efficient of contraction $C_c = 0.6$ and $C_v = 1$. (WINTER 2024, 4 Marks OR)
- **Q.** A vertical sharp-edged orifice of 140 mm diameter is discharging water at the rate of 100 lit/s under a constant head of 10 m. A point, on the jet, measured from the vena contracta of the jet has co-ordinates 4.3 m horizontal and 0.6 m vertical. Determine the co-efficient C_c , C_v and C_d of the orifice. (SUMMER 2025, 7 Marks)

Chapter 6: Flow Through Notches and Weirs

Repeated Questions:

1. Notches and Weirs – Difference, Definitions and Classification:

- **Q.** Distinguish between Notches and Weirs. / Differentiate between Notch & Weir. (**SUMMER 2022, 4 Marks; WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR; WINTER 2024, 4 Marks OR; WINTER 2025, 4 Marks OR; SUMMER 2026, 4 Marks**)
- **Q.** Define notches and weirs. / Give the advantages of triangular notch over a rectangular notch. / Give the classification of notches and weirs. / Explain the classification of notches and weirs with suitable examples. (**SUMMER 2022, 3 Marks; SUMMER 2023, 3 Marks OR; WINTER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 3 Marks; SUMMER 2026, 4 Marks OR**)

2. Discharge over Notches and Weirs (Derivations):

- **Q.** Derive an expression for the discharge over a triangular notch or weir. / Derive an equation of discharge over a triangular notch or weir. (**SUMMER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks OR; WINTER 2025, 7 Marks OR**)
- **Q.** Derive an expression for the discharge over a trapezoidal notch or weir. (**WINTER 2022, 7 Marks; SUMMER 2026, 7 Marks**)
- **Q.** Derive an equation for discharge over a rectangular notch or weir. (**SUMMER 2023, 4 Marks OR; WINTER 2023, 4 Marks OR; WINTER 2025, 4 Marks OR**)

Other Important Questions:

1. Theory – Velocity of Approach:

- **Q.** Explain the concept of velocity of approach. (**SUMMER 2025, 3 Marks OR**)

2. Numericals – Rectangular and Cipolletti Weirs:

- **Q.** A rectangular weir of crest length 60 cm is used to measure the rate of flow of water in rectangular channel. The channel is 90 cm wide and 80 cm deep. Find the discharge in the channel if the water level is 90 mm above the crest of weir. Take velocity of approach into consideration and value of $C_d = 0.63$. [Diagram required – refer to the original question paper] (**SUMMER 2025, 4 Marks**)
- **Q.** A Cipolletti weir of crest length 80 cm discharges water. The head of water over the weir is 340 mm. Determine the discharge over the weir if the channel is 60 cm wide and 60 cm deep. Assume $C_d = 0.62$. (**SUMMER 2025, 4 Marks OR**)

Chapter 7: Flow through open channel

Repeated Questions:

1. Most Economical Section of Open Channel:

- **Q.** What do you mean by "Most economical section" of an open channel? How it is determined? / Derive an expression for most efficient and economical cross section for rectangular cross section. / Illustrate with equation how the most economical section of an open channel is determined. **(SUMMER 2022, 7 Marks OR; SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 7 Marks OR)**

2. Classification of Flow in Channels:

- **Q.** Classification of flow in channels. **(SUMMER 2024, 3 Marks; SUMMER 2026, 3 Marks OR)**

Other Important Questions:

1. Theory – Most Economical Section and Channel Terms:

- **Q.** Prove that rectangular channel will be most economical when hydraulic depth is half of the depth of flow. **(SUMMER 2023, 4 Marks)**
- **Q.** Define: (i) depth of flow (ii) wetted perimeter (iii) hydraulic radius. **(SUMMER 2025, 3 Marks OR)**

Uncategorised Questions

Repeated Questions:

None identified.

Other Important Questions:

1. Define the Following Terms (Truncated):

- Q. Define the following terms: [Data truncated in source – refer to the original question paper]
(SUMMER 2022, 3 Marks)
