# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE-4 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK**

## Subject Name & Code:
## Fluid Mechanics & Hydraulics (3140611)

## Module 1: Properties of Fluids

**Repeated Questions:**

1. **Define: Mass density, Specific weight, and Specific gravity.**
   - Appeared in: S25 (Q1a, 03 marks), W25 (Q1a, 03 marks), S22 (Q1a, 03 marks)
2. **Define: Dynamic viscosity, Surface tension, Capillarity.**
   - Appeared in: W24 (Q1a, 03 marks), W22 (Q1a, 03 marks)
3. **State and prove Pascal's law.**
   - Appeared in: S24 (Q3b OR, 04 marks), W24 (Q1c, 07 marks), W23 (Q1c, 07 marks), W22 (Q1c, 07 marks)

**Other Important Questions:**

1. **Define: Specific volume, Vapour pressure, Compressibility, Elasticity.**
   - Appeared in: S22 (Q1a, 03 marks)
2. **Explain Newton's law of viscosity.**
   - Appeared in: W23 (Q1b, 04 marks)
3. **Define: Kinematic viscosity, Fluid statics, Fluid kinematics.**
   - Appeared in: W23 (Q1a, 03 marks)
4. **Calculate specific weight, density, and specific gravity of a liquid weighing 7 N in 1 litre.**
   - Appeared in: S22 (Q1b, 04 marks)
5. **Write about different types of fluid in detail with example.**
   - Appeared in: S22 (Q1c, 07 marks)
6. **A plate 0.08 mm apart from fixed plate requires stress of 2.25 N/m² to move at 1.80 m/s. Determine viscosity of fluid.**
   - Appeared in: S23 (Q1b, 04 marks)

# Module 2: Fluid Statics

**Repeated Questions:**

1. **Define: Buoyancy, Centre of pressure, Metacentric height.**
   - Appeared in: S25 (Q2a, 03 marks), S24 (Q2a, 03 marks), S22 (Q3a, 03 marks), W24 (Q2a, 03 marks), W22 (Q2a, 03 marks)
2. **Explain different types of equilibrium of a floating body.**
   - Appeared in: S25 (Q1b, 04 marks), S23 (Q3a, 03 marks), W24 (Q2b, 04 marks), W23 (Q2b, 04 marks)
3. **Derive expression for total pressure on a vertical plate submerged in liquid.**
   - Appeared in: S25 (Q2c, 07 marks), W24 (Q2c, 07 marks), W23 (Q2c, 07 marks), W22 (Q2c, 07 marks)

**Other Important Questions:**

1. **What is a hydrostatic paradox? Explain with an example.**
   - Appeared in: S25 (Q2b, 04 marks)
2. **Differentiate between Piezometer and U-tube manometer.**
   - Appeared in: S22 (Q2a, 03 marks), W24 (Q1b, 04 marks)
3. **A vertical rectangular gate 2 m wide and 4 m high is submerged with top edge at water surface. Find total hydrostatic force and centre of pressure.**
   - Appeared in: S25 (Q2c OR, 07 marks)
4. **Prove that rate of increase of pressure in vertically downward direction equals specific weight of fluid.**
   - Appeared in: S22 (Q2b, 04 marks), W24 (Q2c OR, 07 marks)
5. **Calculate pressure intensity 4 m below sea water level (sp. gr. = 10 kN/m³).**
   - Appeared in: S23 (Q2b, 04 marks)
6. **Two pipes A and B with oil (sp. gr. 1.35) have mercury manometer difference 20 cm. Find pressure difference.**
   - Appeared in: S23 (Q2c, 07 marks)
7. **A U-tube manometer measures water pressure. Mercury difference = 15 cm. Find pressure in main line.**
   - Appeared in: S24 (Q3c OR, 07 marks)
8. **A pipe 4 m diameter with oil (sp. gr. 0.87) has pressure 19.6 N/cm² at centre. Find force on gate valve and centre of pressure.**
   - Appeared in: S22 (Q3c, 07 marks)
9. **A differential manometer connected between two pipes A (sp. gr. 1.5) and B (sp. gr. 0.9) shows mercury level difference. Find it.**
   - Appeared in: S22 (Q2c, 07 marks)
10. **Mercury manometer shows 0.3 m differential reading. Pressure in Pipe A is 30 mm Hg vacuum. Find pressure in Pipe B.**
    - Appeared in: W22 (Q2c OR, 07 marks)

# Module 3: Fluid Kinematics & Dynamics

**Repeated Questions:**

1. **Define: Streamlines, Flow nets, Metacentric height.**
   - Appeared in: S24 (Q3a, 03 marks)
2. **Explain Reynolds number and its significance.**
   - Appeared in: S25 (Q3b, 04 marks), W22 (Q3b, 04 marks), W24 (Q3b, 04 marks)
3. **State Bernoulli's theorem with equation and explain its significance.**
   - Appeared in: S24 (Q3b, 04 marks), W22 (Q3b, 04 marks), W24 (Q3b OR, 04 marks)

**Other Important Questions:**

1. **Define: Non-uniform flow, Supercritical flow, RVF.**
   - Appeared in: S24 (Q1a, 03 marks)
2. **Define: Unsteady flow, Flow net, Metacentric height.**
   - Appeared in: S24 (Q3a, 03 marks)
3. **Define: Laminar flow, Streamline, Pathline.**
   - Appeared in: S22 (Q3a OR, 03 marks)
4. **Derive Bernoulli's equation for fluid flow and mention assumptions.**
   - Appeared in: S25 (Q3c, 07 marks)
5. **Which assumptions are made in Bernoulli's theorem?**
   - Appeared in: W23 (Q3a OR, 03 marks)
6. **A stream function in 2D flow is $\Psi = 2xy$. Calculate velocity at (3,2) and find velocity potential $\Phi$.**
   - Appeared in: S22 (Q3b OR, 04 marks)
7. **Show that stream function $\Psi$ always satisfies continuity equation.**
   - Appeared in: S23 (Q3c, 07 marks)
8. **Velocity in x and y direction given by $u = -2y$, $v = 2x$. Check if stream function exists. If yes, deduce it and plot streamlines.**
   - Appeared in: S23 (Q4c, 07 marks)
9. **Define: Velocity potential function and Stream function.**
   - Appeared in: W25 (Q2a, 03 marks)
10. **Define flow net and write in detail its characteristics, applications, and limitations.**
    - Appeared in: S22 (Q3c OR, 07 marks), W24 (Q3c OR, 07 marks)

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# Module 4: Flow Measuring Devices

**Repeated Questions:**

1. **What are hydraulic coefficients of orifices? Define and explain them.**
   - Appeared in: S25 (Q3a, 03 marks), S24 (Q2b, 04 marks)
2. **Define: Coefficient of contraction, Coefficient of velocity, Coefficient of discharge for orifice.**
   - Appeared in: W25 (Q3a OR, 03 marks), W23 (Q3a, 03 marks)
3. **Derive an expression for velocity measurement using Pitot tube.**
   - Appeared in: S25 (Q4a, 03 marks), S22 (Q4c, 07 marks)

**Other Important Questions:**

1. **Define: Venturimeter, Orificometer, Weir.**
   - Appeared in: S24 (Q2a, 03 marks)
2. **Explain different types of orifices according to size, shape, and discharge.**
   - Appeared in: W25 (Q3a, 03 marks), W22 (Q3a, 03 marks)
3. **What is Pitot tube? How is velocity at any point determined with it?**
   - Appeared in: W25 (Q3b, 04 marks)
4. **Derive expression for discharge through triangular notch.**
   - Appeared in: W25 (Q3c, 07 marks), W22 (Q3c OR, 07 marks)
5. **Derive expression for discharge through venturimeter.**
   - Appeared in: W25 (Q3c OR, 07 marks)
6. **Explain components of venturimeter with neat proportionate sketch.**
   - Appeared in: W24 (Q3c, 07 marks), W22 (Q3c, 07 marks)
7. **A horizontal venturimeter with inlet 40 cm, throat 20 cm, manometer reading 15 cm Hg. Find flow rate (Cd = 0.98).**
   - Appeared in: S25 (Q3c OR, 07 marks)
8. **A horizontal venturimeter with inlet 25 cm, throat 15 cm, measures oil flow (sp. gr. 0.8) 70 l/s. Find oil-mercury manometer reading (Cd = 0.97).**
   - Appeared in: S24 (Q2c, 07 marks)
9. **Head over triangular notch 60° is 55 cm, Cd = 0.61. Flow accuracy ±1.7%. Find limiting head values.**
   - Appeared in: S24 (Q2c OR, 07 marks)
10. **Head over 90° V-notch is 0.40 m. Find discharge (Cd = 0.60).**
    - Appeared in: S23 (Q3b, 04 marks)
11. **Orifice meter: orifice 150 mm, pipe 300 mm, manometer diff. 40 cm Hg, oil sp. gr. 0.8. Find flow rate (Cd = 0.60).**
    - Appeared in: S22 (Q4b, 04 marks)
12. **Compare flow discharge measurement by Notch and Weir.**
    - Appeared in: S24 (Q1b, 04 marks)
13. **Write advantages of triangular notch over rectangular notch.**
    - Appeared in: W25 (Q3b OR, 04 marks), W23 (Q3b OR, 04 marks)
14. **Explain term velocity of approach. Find expression for discharge over rectangular weir with velocity of approach.**
    - Appeared in: W25 (Q2b, 04 marks)
15. **Differentiate between small and large orifice.**
    - Appeared in: W24 (Q3a OR, 03 marks), W22 (Q3a OR, 03 marks)
16. **Give classification of orifices. Difference between orifice and mouthpiece.**
    - Appeared in: W23 (Q3b, 04 marks)
17. **A horizontal venturimeter with inlet 30 cm, throat 15 cm, manometer reading 20 cm Hg. Find flow rate (Cd = 0.98).**
    - Appeared in: W23 (Q3c OR, 07 marks)

# Module 5: Flow Through Pipes

**Repeated Questions:**

1. **Enlist major and minor losses in pipes. Derive Darcy–Weisbach equation for friction head loss.**
   - Appeared in: S25 (Q4c, 07 marks), W24 (Q4c, 07 marks), W23 (Q4c, 07 marks), W22 (Q4c, 07 marks)
2. **Derive Hagen–Poiseuille's equation for laminar flow in a circular pipe.**
   - Appeared in: S25 (Q4c, 07 marks), W24 (Q4b, 04 marks), W23 (Q4b, 04 marks), W22 (Q4b, 04 marks), W25 (Q4c OR, 07 marks)
3. **Define: Total Energy Line (TEL) and Hydraulic Gradient Line (HGL).**
   - Appeared in: S25 (Q4b, 04 marks), W24 (Q4a, 03 marks), W23 (Q4a, 03 marks), W22 (Q4a, 03 marks)

**Other Important Questions:**

1. **Draw velocity distribution in pipe flow and open channel flow.**
   - Appeared in: S25 (Q4a OR, 03 marks), W23 (Q4a, 03 marks)
2. **Discuss significance of HGL and TEL in pipe flow analysis.**
   - Appeared in: S25 (Q4b, 04 marks)
3. **Write continuity, momentum, and energy equations for pipe flow.**
   - Appeared in: S24 (Q4a, 03 marks)
4. **Describe Prandtl's mixing length theory with sketch.**
   - Appeared in: S24 (Q4a, 03 marks), W23 (Q4b, 04 marks), W22 (Q4b, 04 marks)
5. **Derive energy-momentum equation.**
   - Appeared in: S24 (Q4b, 04 marks)
6. **Discuss various major and minor losses in pipes.**
   - Appeared in: S24 (Q4c, 07 marks)
7. **Discuss Hardy Cross method to analyze pipe networks in series and parallel.**
   - Appeared in: S24 (Q4c, 07 marks)
8. **Derive expression for loss of head due to sudden enlargement of pipe.**
   - Appeared in: W25 (Q4b, 04 marks)
9. **Explain phenomenon of water hammer and its effects.**
   - Appeared in: S25 (Q3b OR, 04 marks), W25 (Q4b OR, 04 marks)
10. **Enlist minor losses in flow through pipes.**
    - Appeared in: S22 (Q4a OR, 03 marks)
11. **Calculate discharge through pipe diameter 250 mm, pressure head difference 3.5 m over 500 m, f = 0.04.**
    - Appeared in: S22 (Q4b OR, 04 marks)
12. **Pipe diameter 127 mm conveys water. Pressure difference 3.25 m over 250 m. Calculate discharge (f = 0.025).**
    - Appeared in: S23 (Q3c, 07 marks)
13. **Pipe diameter 100 mm conveys water. Pressure difference 0.6 m over 50 m. Calculate discharge (f = 0.025).**
    - Appeared in: W23 (Q3c, 07 marks)
14. **Develop relationship between max velocity and average velocity for viscous flow between two parallel plates.**
    - Appeared in: S23 (Q4a OR, 03 marks)
15. **2 m long pipeline tapers from 10 cm to 20 cm diameter, slopes upward at 30°, pressures 200 kPa and 230 kPa at ends. Find flow rate and pressure at mid-length (no losses).**
    - Appeared in: W24 (Q4c, 07 marks)
16. **Derive Darcy–Weisbach equation for friction loss in pipe.**
    - Appeared in: S22 (Q4c OR, 07 marks)

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# Module 6: Open Channel Flow

**Repeated Questions:**

1. **Differentiate between pipe flow and open channel flow.**
   - Appeared in: S25 (Q5a, 03 marks), W23 (Q5a, 03 marks)
2. **Draw specific energy curve and derive expressions for critical depth and critical velocity.**
   - Appeared in: W25 (Q5c OR, 07 marks)
3. **Derive geometrical conditions for most economical trapezoidal channel section.**
   - Appeared in: S25 (Q5c, 07 marks), W25 (Q5c, 07 marks), W24 (Q4c OR, 07 marks), W22 (Q4c OR, 07 marks)

**Other Important Questions:**

1. **Define: Prismatic channel, Gradually varied flow, Wetted perimeter.**
   - Appeared in: S22 (Q5a, 03 marks)
2. **Explain concept of specific energy in open channel flow with diagram.**
   - Appeared in: S25 (Q4b, 04 marks)
3. **Prove that most economical trapezoidal section has hydraulic radius equal to half the depth.**
   - Appeared in: S25 (Q5c, 07 marks)
4. **Derive relation between critical depth and discharge for a rectangular channel.**
   - Appeared in: S25 (Q5a OR, 03 marks)
5. **A trapezoidal channel bed width 5.5 m, slope 1 in 2000, side slope 1H:0.5V, depth 2 m, Manning's n=0.015. Find discharge.**
   - Appeared in: S25 (Q5c OR, 07 marks)
6. **Describe velocity distribution in open channel flow.**
   - Appeared in: S24 (Q5a, 03 marks), W24 (Q3a, 03 marks)
7. **Find discharge through trapezoidal channel width 8 m, side slope 1H:3.5V, depth 1.9 m, C=45, slope 1 in 5000.**
   - Appeared in: S24 (Q5c, 07 marks)
8. **Discuss direct step method for GVF.**
   - Appeared in: S24 (Q5a OR, 03 marks)
9. **Write Chezy's and Manning's equations with assumptions.**
   - Appeared in: S24 (Q5b OR, 04 marks), W24 (Q4b, 04 marks)
10. **Rectangular channel width 10 m, discharge 18 $m^3/s$, depth 1.4 m. Calculate: i) Specific energy, ii) Critical depth & velocity, iii) Min. specific energy.**
    - Appeared in: S24 (Q5c OR, 07 marks)
11. **For most economical trapezoidal channel section, show that half of top width equals length of one sloping side.**
    - Appeared in: S23 (Q1c, 07 marks), W23 (Q2c OR, 07 marks)
12. **Trapezoidal channel bed width 7.5 m, slope 1 in 3600, side slope 1H:1V, depth 2 m, n=0.015. Find discharge.**
    - Appeared in: S23 (Q2c OR, 07 marks)
13. **4 m wide rectangular channel conveys 30 $m^3/s$. Find critical depth.**
    - Appeared in: S23 (Q4b, 04 marks)
14. **6.25 m wide rectangular channel conveys 18 $m^3/s$ at 4.5 m/s. Check if hydraulic jump can occur.**
    - Appeared in: S23 (Q4b OR, 04 marks)
15. **Rectangular channel width 4.5 m, slope 1 in 1500. Find max discharge (C=50).**
    - Appeared in: W25 (Q5b, 04 marks)
16. **Rectangular channel 6.5 m wide, 3 m deep, slope 1 in 2000, C=55. Find velocity and discharge.**
    - Appeared in: W25 (Q5b OR, 04 marks)
17. **Define: Rapidly varied flow, Gradually varied flow.**
    - Appeared in: W25 (Q5a, 03 marks), W24 (Q4a OR, 03 marks), W22 (Q4a OR, 03 marks)

18. **Define: Supercritical flow, Froude's number, Hydraulic jump.**
    - Appeared in: W24 (Q5a OR, 03 marks), W22 (Q5a OR, 03 marks)
19. **Irrigation lined canal trapezoidal section carries 12 cumec, slope 0.00048, side slope 3H:2V, n=0.013. Find dimensions of most economical section.**
    - Appeared in: S22 (Q5b, 07 marks)
20. **Derive geometrical conditions for most economical section of triangular channel.**
    - Appeared in: S22 (Q5c, 07 marks)

# Module 7: Dimensional Analysis and Similitude

**Repeated Questions:**

1. **Explain Buckingham's π-theorem in dimensional analysis.**
   - Appeared in: W25 (Q2c, 07 marks), W24 (Q5c, 07 marks), W23 (Q5c, 07 marks), W22 (Q5c, 07 marks)
2. **What is dimensional homogeneity? Why is it important?**
   - Appeared in: S25 (Q5b OR, 04 marks), W24 (Q5b, 04 marks), W22 (Q5b, 04 marks)
3. **Discuss geometric, kinematic, and dynamic similarity.**
   - Appeared in: S25 (Q5b, 04 marks), W23 (Q5b OR, 04 marks), W22 (Q5b OR, 04 marks)

**Other Important Questions:**

1. **State and explain theorems associated with dimensional analysis.**
   - Appeared in: S24 (Q1c, 07 marks)
2. **Explain method of selecting repeating variables.**
   - Appeared in: W24 (Q5a, 03 marks), W22 (Q5a, 03 marks)
3. **The efficiency η of a fan depends on ρ, μ, ω, D, Q. Express η in dimensionless parameters.**
   - Appeared in: S22 (Q5c, 07 marks), W25 (Q2c OR, 07 marks)
4. **Define: Reynolds number, Mach number, Weber number.**
   - Appeared in: S22 (Q5a OR, 03 marks)
5. **Write in detail about geometric and kinematic similarity.**
   - Appeared in: S22 (Q5b OR, 04 marks)
6. **Fluid of density ρ and viscosity μ flows at average velocity V through pipe diameter d. Show by dimensional analysis that wall shear stress $\tau_0 = \rho V^2 f(\rho V d/\mu)$.**
   - Appeared in: W23 (Q5c, 07 marks)
7. **The pressure drop ΔP in a pipe depends on v, l, d, μ, k, ρ. Using Buckingham's π-theorem, obtain dimensionless expression for ΔP.**
   - Appeared in: W22 (Q5c, 07 marks)
8. **A pipe of 20 cm diameter conveys water at 5 m/s. Find velocity and discharge of oil in another pipe of 10 cm diameter (μ_oil=0.03 poise, μ_water=0.01 poise, sp. gr. oil=0.75). Assume dynamic similarity.**
   - Appeared in: S23 (Q5c, 07 marks)

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**Additional Repeated Topics Across Papers (General)**

- **Pascal's Law** – Appears in nearly every paper (S22, S23, S24, W22, W23, W24, W25).
- **Venturimeter numerical problems** – Common in S24, S25, W23, W25.
- **Metacentric height & equilibrium of floating bodies** – Common in S23, S24, S25, W22, W23, W24.
- **Bernoulli's theorem derivation & applications** – Common in S24, S25, W22, W23, W24.
- **Darcy–Weisbach & Hagen–Poiseuille equations** – Common in S22, S24, S25, W23, W24, W25.
- **Most economical channel sections** – Common in S22, S23, S24, S25, W22, W24, W25.

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